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BELLIGERENT WARSHIPS IN NEUTRAL PORTS.

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The more important questions relating to the admittance of a belligerent's ships to the ports or territorial waters of a neutral, may be conveniently discussed under three heads: (1) Asylum; (2) Hospitality; (3) A base of naval operations. As these shade into one another, the distinction between them is not always clearly defined however, nor is the attempt made in the following pages to cover the whole ground, but rather to discuss a few of the more doubtful, and it is hoped, the more interesting of the questions involved. That these questions are important, but that they are not answered alike by all the powers, the events of the recent war in the East plainly show.

By asylum is meant the refuge afforded by neutral waters to a ship of war seeking escape from the dangers of the elements, or from the attack of an enemy. Clearly there is a logical distinction between the two forms of danger, since it is the latter only which particularly involves neutrality. Moreover, when a ship seeks refuge in an unseaworthy state, she has an added claim upon the neutral for asylum, because her exclusion without an opportunity to repair would be an act of inhumanity.

The rules applicable to a ship seeking asylum are really in process of making. The usage which governed during the Russo-

Japanese War is quite different from that of the period before our Civil War, though not without precedent. It follows the analogy of the treatment of land forces which have taken refuge from an enemy upon neutral soil. The present usage then has in its favor reasonableness, the argument by analogy, and wide acceptance by both neutrals and belligerents in recent war. It may, therefore, fairly be called the law, although its further test, and an authoritative statement and acceptance of its terms by international conference, would be desirable. Let us see what the present usage is, how it differs from the rule of half a century ago, and how the change has come about.

In the first edition of Woolsey's International Law, published in 1860, the usage of that time is thus stated (p. 356): "In the case of ships of war running into neutral waters in order to escape from an enemy, to demand that they shall either be disarmed, like fugitive troops, or return to the high seas, seems to be a harsh measure and unauthorized by the usage of nations." The author goes on to mention, however, just such a case of "harshness," which is, so far as I am aware, the first instance of the now prevalent practice. "In the recent war between Schleswig-Holstein and Denmark, a small war steamer belonging to the former party, ran for safety, in July, 1850, into the waters of Lübeck, which was on friendly terms with both belligerents. The senate of Lübeck had given orders that vessels of war of either party appearing within its jurisdiction, must lay down their arms or depart beyond cannon shot from the coast. The lieutenant commanding the steamer chose the latter alternative." Lübeck excused its action on the ground that a small state like itself must in its own interest observe "the stricter rules of neutrality." A few citations are given from authors of this period, to show that the opinion stated above, represented the usage then accepted. Halleck uses the phrase in speaking of belligerent ships: "Hence the allowable custom of asylum in neutral waters, and the want of power in the neutral to interfere with internal organization of such vessels, when not armed or equipped within its jurisdiction." Wheaton admits belligerent cruisers to neutral ports, when seeking asylum and hospitality, or even to sell their prizes, but would limit this right at the option of each state in the exercise of its police power. "But" (he adds), "the absence of a positive prohibition implies a permission to enter the neutral ports for these purposes."

Ortolan, a very sound authority in his time (his work, Diplomatie de la Mer, was published before our Civil War), and himself an officer in the French navy, wrote thus: "In default of treaty stipulations neutral ports and waters are an asylum open to the ships of war of the belligerent, especially if they appear in limited numbers; they are admitted to procure necessary provisions, and to make repairs which are essential to enable them again to put to sea and resume the operations of war, without any violation of its duties on the part of the neutral state."

Bluntschli, in 1868, likewise held that the neutral state was at liberty to grant reception and protection to a needy ship, without any limitation of time or circumstance. And Twiss, writing in 1863, said that, unless the neutral had publicly announced to the contrary, belligerent ships with their prizes were entitled to be admitted to neutral ports and to depart unmolested. He adds the following statement, as being the view of the U. S. Government as to the privilege of asylum within neutral waters, issued in 1855, and agreeing with European practice: "Belligerent ships of war, privateers, and the prizes of either are entitled, on the score of humanity, to temporary refuge in neutral waters from casualties of the sea or war." But the neutral may grant such asylum conditionally or even refuse it according to his discretion, if he treats both combatants alike.

These authorities—American, English, French, and German—all agree that it was not held a violation of neutrality in their time for the neutral state to give to a ship flying from its enemy, an asylum unconditioned and in point of time unlimited.

The Civil War in the United States brought home to many governments the necessity of defining such a right of asylum as is under discussion. For after one and another of the nimble Confederate cruisers had begun their devastations, numerous ships were sent in pursuit of them, and Brazilian, Spanish, Dutch, French, and particularly British ports were visited in the search. Sooner or later, the former must be found by the latter. How should both classes of ships be treated? Should unlimited asylum be denied and the Southern rovers be thrust out into the Northern clutches?

To this question, the various proclamations of neutrality from time to time issued, gave a somewhat indefinite answer, but the facts are clear. The British regulations of January, 1862; the

French declaration of June, 1861; the Spanish decree of similar date, all limit asylum to men of war of the two belligerents to 24 hours, except in case of stress of weather, needed repairs, or necessary supplies. The two last orders, however, are aimed at ships of war and their prizes, whether applicable to ships of war without prizes does not appear. Were these limitations of asylum intended to exclude the Confederate ships from neutral protection in case of pursuit? Evidently not. For there is no single case where such a vessel in port was ordered out at the risk of engagement with a Northern cruiser.

The *Florida* in Bahia was under Brazilian protection when illegitimately cut out by the boats of the *Wachusett*.

The *Alabama* at Cherbourg was not driven out to fight the *Kearsarge*, but went out of her own free will.

The *Nashville* spent more than two months at Southampton before she and the *Tuscarora*, which was outside watching her, were both warned away. This, however, was prior to the orders of 1862.

The *Sumter* at Martinique was improperly blockaded by the *Iroquois*. She was not forced to leave but contrived to slip out and elude her pursuer.

These instances illustrate the lax construction of the 24-hours' stay limitation when an enemy was in pursuit. In other words, the usage before the Civil War was still employed during its progress, although on paper the rule governing asylum was made more stringent.

Nor by the usage of nations, nor in the opinion of the publicists, had any material change been made in the rule, down to the opening of the Spanish War of 1898. This is brought out in the very clear and adequate discussion of the rules governing asylum as applied to belligerent ships, which took place in the 1904 session of the Naval War College at Newport, and will be found at page 79, of the "Situations" of that year, a study of various hypothetical cases by the officers in attendance under the guidance of Professor Wilson of Brown University.

Let me summarize the facts there gathered.

The British rule of 1862, was re-issued to affect the Franco-Prussian War in 1870 and our own contest with Spain in 1898. Japan, China, The Netherlands, Italy, Denmark, and Russia, published a similar rule, limiting asylum to 24 hours except in case of

stress of weather, repairs, or other necessities. Brazil is more specific in her proclamation of neutrality. That set the usual limit "except in case of a forced putting into port," which was interpreted to cover "menace by an enemy." In the United States, Grant, by proclamation of October, 1870, virtually copied the British usage.

Hall, usually reckoned the best of recent authorities, bears out the Brazilian usage. (Hall's International Law, 2d Ed., 1883.) "A vessel of war may enter and stay in a neutral harbor without special reasons; she is not disarmed on taking refuge after defeat; she may obtain such repair as will enable her to continue her voyage in safety; . . . . nor is there anything to prevent her enjoying the security of neutral waters for so long as may seem good to her. To disable a vessel or to render her permanently immovable, is to assist her enemy; to put her in a condition to undertake offensive operations is to aid her country in its war." And, he adds, "a tendency toward the enforcement of a harsher rule becomes more defined with each successive war."

Until a comparatively recent time, the gist of the rules was then, that the stay of a belligerent ship was usually limited to 24 hours after its necessities had been satisfied, but that no neutral duty of disarmament was recognized.

Besides this it was usual to forbid the harborage of prizes, and a day's interval in the departure of hostile ships—a very old provision—was enforced.

Was this enough?

The argument from reason and from analogy for an extension of neutral obligation in the matter of asylum was pretty strong.

A ship seeks neutral protection from hostile pursuit. Unlimited protection, enabling her to resume operations, would seem to be more of a direct aid to her side in war, than to enforce immediate departure or internment would be to the other side. For even disarmament is but an acceptance of the fact of inferiority; it implies safety at the price of uselessness; it preserves the status quo; it accords with the dictates of humanity; it accords with the spirit of neutrality. The choice between departure and internment is perfectly free to the ship's commander.

As every one knows, an army driven into neutral territory is not allowed to shelter itself from pursuit and capture, and later resume operations. It receives protection, but at the price of future

uselessness. Humanity and a high sense of neutral obligation demand this course. Why is not the analogy between land and sea forces under substantially similar circumstances a good one? Why should not the same treatment be granted to each?

Within the last decade such considerations have begun to affect the publicist mind.

Here again the reader is referred to the "Situations" of 1904, worked out by the U. S. Naval War College.

Fiore of Italy and Kleen of Sweden, would prevent a ship seeking neutral asylum from its enemy, from taking further part in the war. So concluded also the Institute of International Law at its 1898 meeting: "A belligerent ship, seeking refuge in a neutral port from hostile pursuit, or after defeat by an enemy, or because undermanned, should remain there until the close of the war." Yet others writing at this period hold to the old usage. Thus the matter stood at the outbreak of the Russo-Japanese War: there was reason for the stricter neutrality; there was, however, no general acceptance of it.

During the year 1904 the exception became a rule; internment has been applied to Russian refugee ships in neutral ports by proclamation, or in fact, by the governments of China, of Germany, of France, of Great Britain, and of the United States. Since Korean waters and Korean territory were not treated as neutral, the refuge sought by Russian ships at Chemulpho, which led to the first action of the war, is not properly a case in point.

The first example of the new usage occurred in the case of the Russian gunboat *Mandjur* at Shanghai, at the outbreak of the war. A Japanese warship was sent to patrol the Yangtse estuary giving access to Shanghai harbor. Then, following its rule of 1898, China ordered the Russian away. But this meant destruction, and the Russian refused to budge. There ensued a month of correspondence in which Russia and Japan put alternate pressure upon the Chinese authorities. Finally, after nearly two months' delay, the disarmament of the vessel was ordered.

Here was no question of repairs, no escape from an enemy in hot pursuit. It was a case closely resembling that of the *Nashville* at Southampton and the *Sumter* at Martinique, but how differently treated. My neutrality is not to be disregarded, says the neutral, neither shall violence occur in my waters, nor may a fugitive make them his base. Departure or disarmament, that is your

alternative. So China, although ill able to enforce her neutrality, refused to qualify it by unlimited asylum, and set a precedent for the war. Her rule was the familiar one limiting asylum to 24 hours, so often before issued by various maritime powers. The difference was that it was really enforced and a penalty—disarmament—set.

The fortune of war drove many other Russian ships to seek refuge in neutral ports: the *Gromoboi* and *Askold* in Shanghai; the *Czarevitch*, *Novik*, and some destroyers in Kiau-Chau; the *Diana* in Saigon; the *Lena* in San Francisco; two of Rozhdestvensky's fleet after the battle of the Sea of Japan in the Philippines. All followed the *Mandjur* precedent. Yet President Roosevelt's proclamation of neutrality on February 11, says nothing about disarmament. As a result of Japanese insistence the neutral universally put a stricter construction upon his duties than in any previous war, and a usage was consequently established which will probably be followed in the future.

To simplify the point at issue, nothing has thus far been said about the character and amount of repairs which the neutral will allow to a ship of war finding asylum in his ports, before the 24-hours' rule is applied. To warn out an unseaworthy ship would be in violation of humanity. To allow repairs to armor and armament which would fully renew a ship's fighting capacity, would be a direct and unwarrantable aid in carrying on war, would be, that is, an unneutral act. Clearly the proper usage must lie between these two extremes. A ship may be repaired to the point of seaworthiness; she must not otherwise better her fighting power.

The remark should be added that every neutral must determine for himself what form of dismantling—of rendering unfit for use—he will insist upon. The officers and crew will be interned or paroled. They must not serve again during the war.

Summary: Prior to 1861 asylum was unlimited.

During our Civil War, the 24-hours' limit to stay was generally ordered, but not enforced when it would have driven the sheltered ship into its enemy's hands.

In 1904, the 24-hours' limit was enforced under penalty, namely, of disablement for the rest of the war.

Our second inquiry relates to neutral hospitalities, the permission to a belligerent to procure from the customary commercial sources at a neutral port, the various supplies which are necessary

to his progress, water, food, above all, coal. An insufficient stock of such articles makes a ship of war a dead ship, helpless and vulnerable. As to water and provisions, the rule has varied little for half a century.

To go back no farther than 1862, the British orders allowed the furnishing of supplies necessary for a visiting warship's immediate use, as did Spain's also. This measure of aid in some cases was to be limited to a quantity sufficient to last to the nearest national port, *i. e.*, to comply with the demands of humanity and hospitality, not to aid in the prosecution of the war. As examples of modern usage, let me mention the rule adopted by the Institute in 1898, *i. e.*, by a body of the leading publicists of Europe; Art. 82: "Refuge from the perils of the sea is given to belligerent ships of war only during the stress of danger. They are given water, coal, live stock, and other analogous provisions only in quantity necessary to enable them to reach the nearest national port." Also President Roosevelt's proclamation of neutrality in 1904, which limits supplies to what are necessary for a ship's "immediate use."

But coal is the life of a modern man of war, and has a far more direct connection with military operations than have articles of food and drink. Humanity demands that life shall be sustained; it does not demand that a ship of war shall have the means of approaching an enemy. For in these modern times coal or other fuel is as necessary to a fighting ship as gunpowder. So that the rule allowing a neutral to furnish other supplies to a belligerent warship, may not necessarily apply to coal. To sell it military material is of course strictly prohibited, though allowed in case of a belligerent's merchantman. Our second inquiry then, should concern itself principally with the neutral supply of fuel. Shall the belligerent ship be allowed to procure it freely, or in limited quantity like provisions, or be forbidden altogether, as in the case of war material?

Here again we should turn back to the precedents set by the neutral in our Civil War, for then first did coal play a prominent part in warfare, with the neutral called upon to help out the belligerent's shortage.

This was the rule announced by the British Government early in 1862: "No ship of war or privateer of either belligerent while in any port, roadstead, or waters subject to the territorial juris-

diction of Her Majesty, to take in any supplies except provisions and such other things as may be requisite for the subsistence of her crew; and except so much coal only as may be sufficient to carry such vessel to the nearest port of her own country or to some nearer destination; and no coal shall be again supplied to any such ship of war or privateer in the same or any other port, roadstead, or waters subject to the territorial jurisdiction of Her Majesty, without special permission, until after the expiration of three months from the time when such coal may have been last supplied to her within British waters as aforesaid." Thus coal could be had but under limitations. One naturally asks whether Great Britain had not peculiar interest in introducing this usage limiting the belligerent's coal supply. For the state which has its fortified coaling stations sprinkled over the world, so that its ships of war need not be dependent upon neutral stores, will have an advantage when a belligerent over all other states destitute of such resources, if the neutral coal supply is limited or made precarious. Now in spite of the restrictions of this British order in 1862, it is a matter of history that the Confederate cruisers obtained at British, as well as other neutral ports, practically all the coal they needed. According to British testimony at Geneva, Northern ships also were often favored by a violation of the letter of this order. Yet the Court in the *Alabama* arbitration threw out all claims for damages founded on excessive hospitalities such as implied a breach of the order. The British rule of 1862 as to coal was not copied by other powers at that time. Since then, however, many states have conformed to it. The United States did so in 1870, and various powers in 1898, to apply to our war with Spain. The Institute of International Law adopted this rule also in 1898. Brazil, in 1898, forbade the belligerents to receive in her ports "goods coming directly for them in the ships of any nation whatever." Yet the *Oregon* circumnavigated South America, coaling from place to place. The rule of Italy in 1895, allowed a re-supply of coal subject to a slight restriction: "Such belligerent ships of war as wish to re-supply themselves with coal shall not receive that supply until 24 hours after their arrival." The rule of the Institut de Droit International, adopted in 1898, allowing ships enough coal to reach their own nearest port, has been already quoted. And so the matter stood at the outbreak of the Russo-Japanese War. There was a fairly general agreement

amongst publicists that coal could be furnished without breach of neutrality, but in limited quantity. There was a tendency amongst the commercial powers to follow the British precedent. Yet France, Italy, Spain, possibly other powers had never conformed to this usage. Nor have they considered coal as contraband.

Every one remembers the Russian demands upon the neutral coal supply in 1904 and 1905. Getting coal from neutral ports, from colliers in neutral waters, and from transhipment of coal at sea, occasional Russian war vessels patrolled the sea in the early months of the struggle, and later a great Armada made its way around the globe to meet its fate in the Sea of Japan. Was this concession of the neutral an unneutral act? Had the prevalent usage become a law? Certain differences in the usage there certainly were, and in the direction of greater strictness. Take our own case, for instance. The American rule laid down by the President's proclamation of neutrality, February 11, 1904, was as follows: Furnishing supplies is forbidden . . . "except so much coal only as may be sufficient to carry such vessel, if without any sail power, to the nearest port of her own country; or in case the vessel is rigged to go under sail, and may also be propelled by steam power, then with half the quantity of coal which she would be entitled to receive if dependent upon steam alone," and the British "three months" stipulation is added.

The Netherlands, owning colonies along the route to the East, adopted in February, 1904, the stricter policy of forbidding belligerent ships to procure provisions or fuel in Dutch ports, without the previous sanction of the authorities. That is, the presumption was against the practice, but permission might be granted, the usual rule of other powers being to permit the practice unless specially prohibited. And Denmark, Norway, and Sweden published in May, 1904, according to the statement of Professor Lawrence, in his "War and Neutrality in the Far East," the strictest rule of all the powers, closing their ports to the public vessels—except hospital ships—of both belligerents. One other neutrality order should be cited, to show how varied they were, that of Egypt. This required the commander of a ship of war applying for coal, to state his destination and amount of coal on hand, upon which he may have additional coal, enough for this run only. This privilege is said to have been abused by the

Dmitri Donskoi, which secured coal for the voyage to Cadiz, but used it to patrol the Mediterranean entrance of the Suez Canal.

Enough has been said to show that a belligerent's coal supply in neutral ports is to be regulated by that neutral; can neither be insisted upon by the belligerent as a right, nor if allowed, regarded as an unneutral service; that it is customary to furnish coal, but under various conditions and limitations; that there is no definite rule, but only a growing usage, in which no uniformity exists; that France and Italy have never set restrictions to the practice; that the Confederate cruisers in our Civil War, the *Oregon* in our war with Spain, and the Russian vessels in 1904-5, restrictions or no restrictions, were never seriously hampered in their voyages by lack of coal. In view of these considerations the conduct of France in permitting Russian ships to supply themselves with coal at its ports, or to load from colliers in its waters, both at home and at Jibuti, Madagascar, and Indo-China, should not be viewed as a violation of law, but would seem to accord with customary French usage, so long at least as these French ports were not turned into a base for Russian operations.

This introduces the third question proposed. What is the modern rule as to making out of neutral territory or waters a military base? Did France violate this rule in Russia's interest?

The term "base of operations" as applied to naval warfare is a somewhat indefinite one. Is it a place from which ships can sally forth on errands of war and to which they can retreat when hard pressed; or is it a naval rendezvous where portions of a fleet can gather; or is it a coaling base to which the belligerent resorts more than once and is thus enabled to patrol certain tracts of sea without revisiting his own country; or is it any and all of these? The term occurs in the second of the Three Rules of the Treaty of Washington. At Geneva the British contention was that "a base of naval operations" meant the use of neutral territory as a station or point of departure from which to watch for and attack the enemy. This would exclude the rendezvous and coaling-base ideas from the definition. But the Court in the *Alabama* claims case took a broader view: "Whereas, in order to impart to any supplies of coal a character inconsistent with the second rule, prohibiting the use of neutral ports or waters as a base of naval operations for a belligerent, it is necessary that the said supplies should be connected with special circumstances of time, of persons,

or of place which may combine to give them such character." Repeated coaling at the same neutral port then, might make that port a base of naval operations.

It would likewise seem that the use of neutral waters as a safe gathering point for belligerent ships, from which in company they could move against an enemy, is as categorical an illustration of a base of naval operations as can be imagined. Therefore, for the present inquiry we may be justified in assuming that the use of a neutral port as a base of operations may consist in any one of the three acts named, and ask whether France offended against the law in this respect.

The facts, so far as one can gather them from the only sources of history yet open, the newspapers, are as follows: In the early months of the Russo-Japanese War, the French port of Jibuti served as a gathering place for Russian ships which passed the Suez Canal apparently on their way to the East. On February 17, one Russian cruiser and three torpedo boats passed Perim, going towards Jibuti. There had already gathered at Jibuti one Russian battleship, three cruisers, one torpedo gunboat, and eleven destroyers. There the fleet of Admiral Wirenius spent a week, until ordered away by the French authorities. After 36 hours he obeyed, February 23, having coaled from his colliers in French waters. But affairs were not propitious for an Eastern voyage, and he was ordered by the Russian Admiralty back to Libau. He seized several prizes and brought them with him to the Gulf of Suez. Using that anchorage as a base he overhauled other neutral ships, viz., two British and one Norwegian collier. Egypt protested and Wirenius passed through the Canal to Port Said, the colliers having been released by order of the Czar. Egypt continued to protest, for Wirenius repeatedly overstayed the time limits imposed by her neutrality regulations, but on March 5, the Russian squadron promised to sail for Cadiz. It went to Suda Bay in Crete, and thence was ordered to the Piraeus, the London *Times* of March 26 printing the order along with a statement from St. Petersburg, that Greece was expected to show the same "friendly neutrality" that France had exhibited at Jibuti.

Meanwhile one of the Russian cruisers, the *Dmitri Donskoi*, having gotten coal for Cadiz (as the regulations required an applicant to give his destination), used it to patrol the approaches to the Canal for several days. On March 20 she joined the fleet at Suda Bay.

Examine these naval movements for a moment. Egypt on February 12 had issued a neutrality order which forbade belligerent ships to use her waters "as a station or place of resort for any warlike purpose." To anchor near Suez and search and seize passing ships would seem to be such an infringement of this order as to warrant protest. Egypt did protest and saved her neutrality. But was the conduct of France correct, in allowing a hostile fleet to gather at Jibuti, which became a port of call and a coaling base, for all Russian war vessels bound to the East? France, as shown by her order during our Spanish War, issued April 26, 1898, does not set a time limit to the stay of belligerent vessels in her waters. This rule was brought to the notice of her agents by circular in February, 1904. This contained two provisions which are to the point:

(1) "In no case can a belligerent make use of a French port, or one belonging to a protected state, for a warlike purpose."

(2) "The duration of the stay which belligerent vessels not accompanied by a prize may make in our ports, has not been defined by any special regulation. But in order to obtain authorization to make such a stay they are required to conform to the ordinary conditions of neutrality." A summary of these conditions followed, and amongst them was this: (c) "they must abstain from making the place they are in, the base of any operation against their enemy." Thus no 24-hours' limit was set to a visiting belligerent's stay; he might buy coal as we have seen above, but he must not use the port for warlike purposes, for a base of operations. In this particular the French order unquestionably voices the prohibition of international law.

That Wirenius and his ships did make Jibuti a base of operations is not perfectly clear, yet surely their actions were capable of such construction. Russian vessels came and went, and Jibuti was their gathering place for the next forward movement. But the recall to Libau came, Japan made no formal protest, and the question has importance only because such benevolence of neutrality was shown as emboldened a later mariner, Admiral Rozhdestvensky, to presume further.

After the Russian Armada had left European waters and the North Sea incident behind it, the heavy portion of the fleet coasted Africa, its progress revealed by successive belated dispatches which appeared in the London *Times*. Thus five battleships, three

cruisers, and eight other vessels arrived November 26, off Gaboon in the French Congo, anchored four miles from land, and coaled until the 30th, from seven colliers awaiting them. Warships and colliers met again December 6, at Great Fish Bay in Portuguese West Africa; then December 11, off Angra Pequena in German Southwest Africa, but here wind and sea prevented coaling until the 14th.

December 29 and 30, the collier fleet put in at St. Mary's Island on the east coast of Madagascar and found the Russian fleet already there. The rumor was that Diego Suarez, at the northerly end of Madagascar, was to be the rendezvous, where other colliers, transports, cruisers, and torpedo craft coming through the canal were to join. In point of fact it was at Nossi Bè, inside the northerly portion of Madagascar, that the Russian ships gathered, provisioned, exercised their raw crews, and practised gun-firing. Their stay lasted approximately two months and a half. The *Times* of January 18 brought news of the meeting of two divisions of the fleet in these waters, territorial French waters, since Madagascar had become a colony of France. Rozhdestvensky was reported at Nossi Bè February 2, February 16, February 26. A Messageries boat saw five warships at Jibuti, evidently on their way to join him. Seventy ships, counting colliers, were at Nossi Bè February 16. The Japanese state that the squadrons of Rozhdestvensky, Fölkersahn, and Botrovsky concentrated in Madagascar waters and sailed eastward March 16.

How is this extensive use of neutral waters to be regarded? There has been nothing like it in modern warfare. Maneuvering; training; provisioning; coaling; concentrating for the forward movement. Does all this make of Madagascar waters a "base of operations against an enemy," "a place of resort for any warlike purpose," as the French order ran, or does it not?

And still France made no objection, and Japan made no protest.

The second week in April Rozhdestvensky appeared off Singapore. His journey to the scene of conflict, in which people had begun to disbelieve, was now certain. But before making his final advance, he had to learn what had happened since March 16, to provision, to coal, above all to give the third Russian squadron under Nebogatoff, who had left Libau February 15, and was at Jibuti April 3 and for five days thereafter, a chance to join him. Where could he find facilities for all this? Only by tres-

passing once again upon the neutrality of France which had already proved so benevolent.

Avoiding Saigon, Rozhdestvensky proceeded some 250 miles up the coast of French Indo-China to Kamranh Bay, where he was reported April 14. He had probably arrived a day or two earlier. There he spent two weeks, sailing April 26. What went on during this long stay we learn from the slowly transmitted reports of passing vessels and of news gatherers. The fleet was coaling in Kamranh Bay April 15 and 20 and 26. It lay inside the bay as well as outside. Russian destroyers issuing, visited passing steamers. The London *Times* of May 8 printed a dispatch sent from Saigon April 30, but refused transmission by the French officials: "During my visit to Kamranh Bay, my personal observations convinced me that without French assistance, which allowed the Baltic fleet to rendezvous there, to receive the fullest supplies of coal, cattle, water, fresh and other provisions, and also to make full use of the French telegraphs, the Russian fleet would have been in sad straits."

This long stay at Kamranh, with a purpose, caused great and growing indignation in Japan. The French sufferance of Rozhdestvensky was regarded as inconsistent with neutrality; it threatened to result in an enlargement of the field of war; it might be overlooked in Western waters, not so in the East. The attention of the government was called to it by Mr. Motoro, the Japanese minister to France. The French Admiral Jonquières was at Kamranh during nearly the entire stay of the Russians. Undoubtedly he tried to make them move on, but they were hard to budge. It was rumored that France had appealed to the Czar to order the fleet away, and that it left on the 22d in consequence of the direct orders of the Czar and the pressing representations of the Governor-General of Indo-China. But its departure, if real, was but temporary, for the London *Times* correspondent saw the whole fleet outside Kamranh on the 26th, in an immense arc, torpedo boats darting about, four converted cruisers and a destroyer coaling inside from German colliers. With great relief the civilized world heard of the final departure of the fleet from Kamranh on the 26th, and believed the critical situation to be ended. Quite the contrary. For the very next day thirty or forty Russian vessels were reported at Honkohe Bay some sixty miles up the coast. The *Times* of May 6 printed news of its doings. The cruisers

issue forth and visit neutral merchantmen; part of the fleet is in the bay, within French territorial limits; Rozhdestvensky wants to hang about until joined by the third Russian fleet under Nebogatoff.

Japanese protests were renewed. The situation was more strained than ever. The French seem to have become seriously anxious that their troublesome guests should move on, but had not the power to make them do so. Rozhdestvensky promised to leave on the 3d, but was still at Honkohe on the 8th. On the 12th there were reported still in Honkohe Bay seven battleships, seven cruisers, two destroyers, four converted cruisers.

Meanwhile Nebogatoff was drawing near. He appeared near Saigon May 9, preparing to go up the river, but was warned away by French officials. A scout from the main fleet met him and told of the French wish that the junction should take place outside of territorial waters. It was really effected within a day or two of this date. Yet there was further delay, and the final departure of the united fleets did not take place until May 14. Jonquières reported no Russian ships after the 14th on the coast of Annam, although as late as the 19th some were said to be at Port Dayot. From Annam the fleet sailed north and the naval engagement of Tsu-Shima Straits took place on May 27 and the subsequent days.

I have related the movements of the Russian ships thus minutely, from the best sources of information at hand, to enable the student to draw his own conclusion as to the object of delay and the legality of the proceeding. For the third time the Russians used French waters, the nearest to their objective available, to coal, to provision, to get news of Nebogatoff's advance, and to unite with him. Warned away from one place, they went to another hard by. It was a place of rendezvous, a base of naval operations. It was using a French port "for warlike purpose," in violation of the French order.

Is France to be condemned for this violation of her neutrality? Her natural defense would be that the Russian fleet in great measure tried to observe the letter of the law by lying outside of territorial waters; that a proper set of rules for the preservation of neutrality had been laid down and proclaimed; that the violation of these rules in remote ports by a force overwhelming and unmanageable cannot fairly be charged up against her. In rebut-

tal one must look at the cumulative nature of the offense. At Jibuti, still more certainly at Nossi Bè, France had set precedents, upon which Russia would be sure to rely in Indo-China. Can she exculpate herself by a claim of surprise or of helplessness at the repetition in aggravated form, of an offense hitherto condoned? Did she show a diligence in the matter of enforcing her neutrality "in exact proportion to the risks" which threatened one of the belligerents from a lack of due diligence? After the Madagascar experience, should not France have given Admiral Jonquières the means of enforcing her laws in the East? Could she not have brought such pressure upon her ally Russia as to prevent Rozhdestvensky's high-handed and scandalous conduct?

Such is the line of thought which has led me at least to the conclusion that the neutrality of France was violated by Russia in the instances given, to the detriment of Japan, by France's own guilty sufferance; that she allowed her waters to be used as a "base of naval operations," "for a warlike purpose," with insufficient effort at prevention to relieve herself of responsibility. Far different was the action of Great Britain in ordering Dewey and his ships out of Hong-Kong at the outbreak of the Spanish War; nor did the Portuguese Government suffer Cervera to make use of the Cape Verde Islands indefinitely, to further his plans for the relief of the Spaniards in Cuba.

These then are the conclusions to be drawn from this study of the rules governing belligerent warships in neutral waters, in the light of the recent war:

(1) That the rule has become established to grant asylum for 24 hours only, subject to penalty.

(2) That no prevalent rule exists forbidding a reasonable supply of coal to be given visiting ships at neutral ports.

(3) That on a vast scale Russia made illegal use of French waters as a base of naval operations, permitted, or at least not prevented, and that France is responsible therefor.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE BATTLE OF THE SEA OF JAPAN.

By CAPTAIN RICHARD WAINWRIGHT, U. S. Navy.

Many accounts of the naval fight in the Sea of Japan have been written, and some of them by writers accustomed to treat of naval subjects. There would not be any reason for writing another account had not these accounts been written so soon after the battle as to leave many important points obscured.

Now, that the detailed report of Admiral Togo has been published, it is possible to correct errors in the earlier accounts and to clear up some uncertainties. The translation of the report as published in the *Army and Navy Journal* is relied on in this account. Even this detailed report requires much study, and comparison with other reports, for a clear understanding of the situation; as it has lost something in translation and something possibly in its hurried preparation.

In writing this account it is attempted to clearly show the various tactical maneuvers, and to separate the work of the battleships, armored cruisers, cruisers, and torpedo flotillas. There is no mention of the use of mines or of submarine boats in any of the reports.

After outlining the various phases of the battle such deductions are drawn by the writer as the facts seem, to him, to warrant. As in most sea fights, there are so many factors influencing the results that it is difficult to prevent personal bias and preconceived opinions from entering into the deductions. There are more unknown quantities than equations and they cannot all be solved exactly.

The victory was complete and nearly all the Russian fleet was destroyed or captured; but how much of this victory was due to better training, to superior forces, armored or unarmored, to bet-

ter shooting by large and intermediate caliber guns, to torpedoes, to the tactics of the victorious Admiral and to the superior speed of his fleet are all questions to be answered.

On the morning of August 27th the strength of the Japanese fleet was anchored near Masampho. There was a strong breeze from the southwest with a rough to moderate sea, and the mist was thick enough to obscure all objects at a distance of five miles.

At 5 a. m. Admiral Togo received a wireless report, from the *Shinano Maru*, that the Russians had been sighted and that they were steering for the eastern channel of Tsushima Straits. At 7

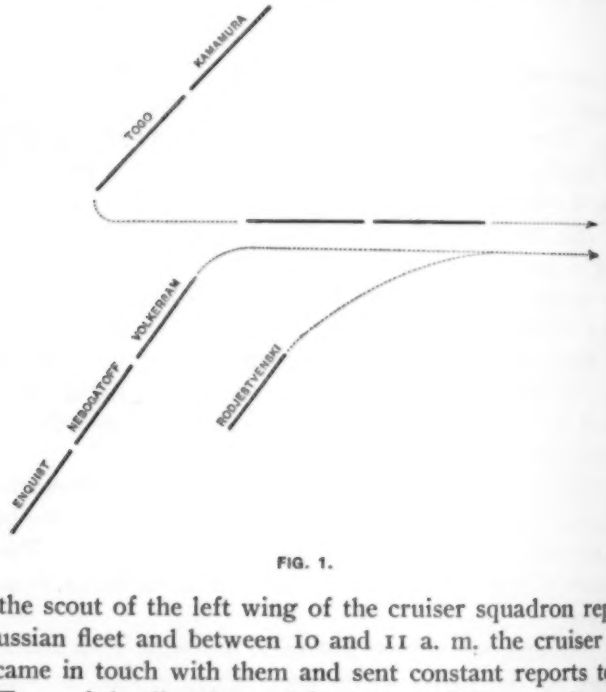

FIG. 1.

a. m. the scout of the left wing of the cruiser squadron reported the Russian fleet and between 10 and 11 a. m. the cruiser squadron came in touch with them and sent constant reports to Admiral Togo of the direction and formation of his enemy's vessels.

They were in double column, with four ships of the *Borodino* class in the right and three battleships with one armored cruiser in the left column, followed by the smallest battleship and three coast-defense vessels. To the front and between the columns were two fast cruisers, and to the rear three armored cruisers, several cruisers and the special service vessels, all steering in a northeasterly direction at about 12 knots.

When Admiral Togo was informed of the approach of the Russians and of the number and disposition of their ships, he decided to attack them, according to prearranged plans, after they had entered the straits, with all his armored fleet, his four battleships leading. He determined to meet the enemy near Okinoshima about two in the afternoon.

When the Russian fleet was sighted off Okinoshima, still steering northeast and in double column, Admiral Togo led to the southwest in single column as if he intended to pass to the westward of the Russians, and on a parallel line of bearing to them. At 2.05 p. m., when about four miles distant from them, he turned sharply to the eastward, and the Japanese being nearer the key and having superior speed, this forced the Russians to turn gradually to the eastward until the two lines of bearing were again nearly parallel (see Fig. 1). The Russians opened fire first after Admiral Togo turned to the eastward, but the Japanese waited until the range was under seven thousand yards and when it was decreasing rapidly.

The Japanese concentrated their fire on the two ships leading the columns. The *Osliabia,* the leading ship of the left column, the nearest to the Japanese, soon showed the effects of this fire and dropped out of line.

As the Russians turned to the eastward, they appear to have formed into single column. In General Liniévitch's report, he says: "The first division of battleships inclined two points to starboard and placed itself at the head of the second division of battleships." Admiral Togo says: "The enemy seemed to be gradually pressed towards the southward and eastward, and both their right and left lines gradually wended their way to the east, the enemy's fleet in consequence being formed into an irregular single column and proceeding parallel with our fleet." Having been caught in double column, with the Japanese fleet capping them, the best move for the Russians was to form single column, by each head of column turning four points to starboard, that is, east. This they apparently did.

The range must have decreased rapidly after fire was opened. General Liniévitch says: "The battle began at 60 or 70 cables distance. Afterwards the squadrons approached to 20 cables." Admiral Togo says: "At 2.08 p. m. the enemy first opened fire. We bore the fire for a while and reaching the range of 6000 me-

ters we concentrated a fierce fire on the two warships which were at the head of the enemy's lines. . . At this time the whole of our armored cruiser squadron joined the battleship squadron towards the rear, and the concentrated fire of our entire fleet increased its efficiency in proportion to the decrease of the distance."

The Russian armored squadron continued to the southward and eastward until 3 p. m. The Japanese with higher speed overlapping the head of their column and pressing it to the southward. Before 2.45 p. m. Admiral Rodjestvenski's flagship, the *Kniaz-Souvaroff*, which was leading the column, and the next after her, the *Alexander III*, dropped out of line, both vessels being on fire. "The confusion in the enemy's formation became more and more evident, and fire occurred on several vessels which were bringing up the enemy's rear. . . . Such being the main features of the fighting between the opposing main forces at about 2.45 p. m., the issue of the day was already decided at that time."[1]

About this time the *Asama*, of the Japanese armored cruiser squadron dropped out of line. She was hit by three shells near the water line aft. Her steering-gear was damaged and she was leaking badly, but she was able to effect temporary repairs and to rejoin the line. This was the only Japanese ship sufficiently injured to be forced out of line.

At 3 p. m., because of superior speed, and possibly, because the Russians did not take advantage of moving on the interior circle, and turn more rapidly, the Japanese were ahead and overlapping the Russian line. The leading Russian ship then headed to the northward, followed by the others in succession, as if to attack the Japanese rear. Admiral Togo's squadron then went left about, heading to the northward and westward. Admiral Kamamura's squadron continued on inside of Togo's squadron and countermarched so as to bring up in Togo's rear.

There is some doubt left in the reports of Admiral Togo as published, just how the second division performed this maneuver. Undoubtedly it passed inside the first division (Togo's), while the latter was changing direction by vessels left about, and thus keeping up a continuous fire on their enemy. But whether after clearing the first division they went by vessels left about or countermarched seems uncertain. In the official telegraphic re-

[1] This was thirty-seven minutes after opening fire.

port, Admiral Togo says: "Our armored cruisers changed front in like manner, following the same direction, and pressing the enemy towards the south." In his detailed report he says: "The armored cruiser squadron changed its front, after doubling on its own track, and followed the battleships. The enemy was thus again pressed to the south and subjected to a galling fire."

Either way it was a very pretty and effective maneuver. While Togo was turning, when the rapid change in train of his guns would prevent effective firing, Kamamura was passing inside, keeping up his fire and uncovering the first division when it had completed the turn and was able to maintain a steady fire on the Russian column (see Fig. 2).

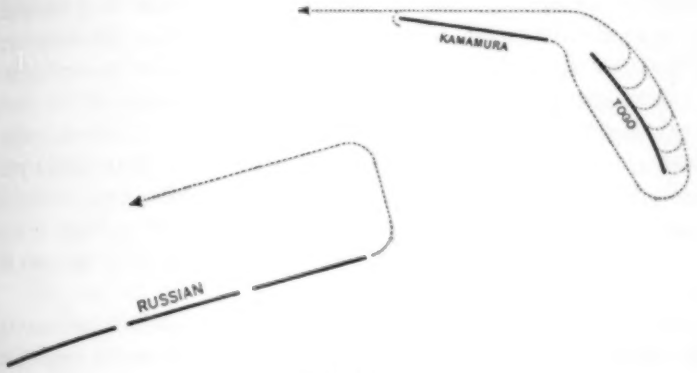

FIG. 2.

As the Russians were forced to head more and more to the westward the first division of the Japanese continued ahead, leading to the westward, the second division following. The Russians turned once more, heading first to the northward and then to the eastward, and the former maneuver was repeated, only Togo's division went by the right about instead of left about as in the first occasion. This turning, to the left about in the first position and to the right about in the second, showed Admiral Togo's familiarity with practical tactics. As we all know, who have used the game-board, it is necessary to turn from the center of the circle, and it is not well to wait to learn this lesson until actually exercising a squadron as turning toward the center is apt to bring the vessels turning at very close distance if not in collision.

From this time the movements of the fleets are somewhat uncertain, the Russian fleet was forced to the southward and was pursued by the Japanese. In the telegraphic report Admiral Togo says: "At 3.40 the enemy seemed to have turned to the south. Later we lost him from sight in the smoke and the fog.

"At 4.30 our principal squadron again steamed towards the north, seeking the main force of the enemy. Our armored cruisers went southward against the enemy's cruisers."

In the detailed report he says: "At about 4.40 p. m. the enemy, probably despairing of cutting their way to the north, seemed to be gradually flying to the south. Thereupon the main strength of our fleet, with the armored cruiser squadron at its head, pursued the retreating enemy. The latter were soon after lost sight of in smoke and mist. We thus steamed down to the south over a distance of eight miles, quietly firing upon the second-class cruisers, the special service vessels, and other ships of the enemy lingering to the right of us. At 5.30 p. m. our battleship squadron again turned its course to the north in search of the enemy's main force, while the armored cruiser squadron went to the attack of the enemy's cruisers by taking a southwesterly course. These two squadrons of ours being thus separately engaged did not see each other until sunset."

The time of separation is worthy of notice, as in some accounts of the battle Togo separated his armored fleet in the beginning, sending Kamamura's squadron westward of Tsushima to attack the Russian fleet in the rear. This would have indicated a lack of prudence most unusual in all of Admiral Togo's work.

It is now time to show the work of the cruisers from the beginning of the battle until sunset. At 5 a. m. on the 27th the first report of the approach of the enemy was sent to Admiral Togo by wireless from the *Shinano Maru*, an auxiliary steamer; and at 7 a. m. the *Idzumi*, one of the cruiser squadron (Kataoka's), reported sighting the enemy steering northeast. The *Idzumi* was a scout on the left wing of the inner cordon. Togo says: "Between 10 and 11 a. m., the cruiser squadron (under Vice-Admiral Kataoka), the Togo detachment (under Rear-Admiral Togo), and the Dewa detachment (under Vice-Admiral Dewa) came into touch with the enemy between Iki and Tsushima; and notwithstanding repeated firing by the enemy, these sections of our fleet maintained uninterrupted touch with the enemy as far as Okino-

shima,[1] all the while constantly and minutely telegraphing to me about the condition of the enemy."

When, at noon, Admiral Togo with the main strength of his fleet reached a point about 10 miles north of Okinoshima, he had with him the Uriu detachment of cruisers and at about 1.30 p. m. he was joined by Dewa's cruisers one after the other. At 2.05 p. m., when he headed to the eastward to cap the Russian fleet, the cruisers under Dewa and Uriu, in pursuance to prearranged plans, steamed to the southward and joined the other cruiser divisions in attacking the rear of the Russian fleet.

Togo in his detailed report says: "At 2.45 p. m. the Dewa and Uriu detachments, maintaining touch with each other, first opened fire, in reversed lines, upon the Russian cruiser squadron, and gradually making a detour to the enemy's right across the rear, then opened fire in parallel lines. Availing themselves of their superior speed, these detachments frequently went about, and appeared now to the enemy's left and then to the right, thus continuing the attack for some thirty minutes. The Russian rear detachments were thus gradually thrown into disorder, and the special service ships after repeatedly changing their course were at a loss as to their own disposition.

"At 4.40 p. m. four Russian battleships (or coast-defense ships), pressed from the north by our main fleet arrived and joined the Russian cruisers, so that the Uriu detachment and the cruiser squadron were for a time engaged at a short distance in an arduous fight with a powerful enemy. As a result all the vessels of these two squadrons sustained damages, which, however, were fortunately not serious."

The remainder of the time was occupied in contests between various ships and groups of ships resulting in serious losses to the Russians, whose fleet was scattered. At 7.20 p. m. the various Japanese divisions were ordered to assemble at Matsushima.

The torpedo flotillas took their part in the battle; but as might have been expected very little was attempted before dark.

From Admiral Togo's report it is gathered that there were several of the destroyer flotillas with the armored fleet and one with the cruiser squadron.

"Special mention must be made of a stirring incident that took place during this period of the battle; namely, the daring torpedo

[1] The island where Admiral Togo first struck the Russians.

attacks made upon the enemy's disabled ship, the *Souvaroff*, by the Chihaya and the Hirose destroyer flotilla (under Captain Hirose), at about 3.40 p. m., and by the Suzuki destroyer flotilla at about 4.45 p. m. Although the result of the former attack was uncertain, it was observed that one of the torpedoes discharged on the occasion of the latter attack struck the enemy's vessel on the port-side aft, causing the vessel to list ten degrees.

"During these torpedo attacks the *Shiranui*, of the Hirose flotilla, and the *Asashio*, of the Suzuki flotilla, were hotly fired upon by the enemy's vessels in the neighborhood and were each hit by a shot. They were for a time in a dangerous condition, but fortunately they were able to save themselves."[3]

Evidently this attack was not pressed home, as only one torpedo was known to hit and only two destroyers were injured. Probably it was as closely pressed as was advisable in day time, even against much battered ships.

Later the Fujimoto torpedo-boat flotilla, which accompanied the cruiser squadron, attacked the *Souvaroff* once more. The battleship at this time could only attempt to drive off the boats with one small gun in the stern and she was struck by two torpedoes and sank at 7.20 p. m. These are the only attacks made by torpedo boats in the day time on the 27th. The *Navarin* was sunk by torpedoes during the day time on the 28th.

The strong southwest wind kicked up quite a sea during the 27th, and early in the day Admiral Togo sent many of his destroyers and torpedo boats to anchor at Miura Bay on the east side of Tsushima. Toward evening the wind was somewhat lighter but the sea continued rough for effective torpedo work. Lieutenant Soejima, who commanded torpedo boat No. 35 that night, says: "At that time the sea was very rough. The waves washed the deck and spray entered through the funnel. About thirty feet of the fore part of the boat was practically under water. I was standing behind the conning-tower and the water fell upon me like a waterfall now and then." Still the opportunity could not be lost and the various flotillas were gathered ready to attack the battered and defeated fleet at dark.

Little can be learned from the reports of the tactics of attack used by the torpedo flotillas. The Japanese fleet steamed clear of the Russian ships. The armored ships to the northward and

[3] Admiral Togo's detailed report.

the cruisers mostly to the southward, leaving the field clear for torpedo work.

The night was dark and there must have been some unavoidable confusion and much difficulty in finding the enemy. Lieutenant Soejima says: "At 8.45 p. m. lost sight of the leading boat on account of the high seas and darkness. We searched for it but could not find it. So fearing to miss the chance we decided to attack singly, and rushed underneath the enemy's searchlights increasing our speed."

The flotillas surrounded the Russian fleet and delivered their attacks practically simultaneously, and they must have pressed them close home, as some of the Russian reports state that the Japanese boats came so close that the guns of the vessels attacked could not be depressed sufficiently to be effective. Lieutenant Soejima says: "When they turned their searchlight we saw men on the after deck, and thus we knew that we were very near to the ship (from 160 to 200 yards)."

Only three Japanese torpedo boats were sunk, and four destroyers and three torpedo boats were injured by collision or the enemy's gun-fire. The crews, of the boats that were sunk, were rescued by other boats. This illustrates the condition of the Russian ships at this time and shows something of the effect of the Japanese gun-fire during the day. The Russians must have done far greater damage than this, but for the serious destruction of the material and the crew prior to the night attack.

Admiral Togo reports: "The first torpedo attack was made at the enemy's head by the Vajima destroyer flotilla at 8.15 p. m., and then all destroyer and torpedo-boat flotillas clustered around the enemy and repeatedly delivered furious attacks until 11 p. m. The enemy lighted his searchlights from sunset and defended himself most strenuously. But at last unable to hold out against our attacks, his ships were scattered in every direction, and each ship struggled to find her own way of escape. They were chased by our attacking forces and a fierce engagement ensued in all directions. During this time at least three ships—the battleship *Sissoi Veliki* and armored cruisers *Admiral Nashimoff* and the *Monomach*—were utterly disabled by our torpedoes either for fighting or for steaming."

At daylight of the 28th the Japanese armored fleet were twenty miles south of Matsushima. The other squadrons, detachments,

and flotillas were on their way to the rendezvous, the cruiser squadron was sixty miles further to the southward and between them and the armored fleet was a remnant of the Russian fleet under Rear-Admiral Nebogatoff's command. These were two battleships, the *Orel* and *Nicholas I*, two coast-defense ships, *General Admiral Apraxin* and *Senjavin*, and the cruiser *Izumrud*. The mist had cleared away so the Russians were soon sighted and surrounded by the Japanese fleet when they all surrendered except the *Izumrud*, which, taking advantage of her high speed, escaped toward the north.

Cruisers, destroyers, and special service ships were then used to sweep the seas and round up the scattered Russians. The destroyers being generally in company with one or more cruisers.

After the surrender of Admiral Nebogatoff the greater part of the armored fleet remained in that vicinity. About 3 p. m. the *Admiral Oushakoff* was discovered coming from the south. The *Iwate* and *Iakumo* were sent after her. She resisted manfully and was sunk, about three hundred survivors of her crew being rescued.

About 4.45 p. m. the Commander-in-Chief of the Russian forces, Vice-Admiral Rodjestvenski, who was badly wounded, was captured with his staff in the destroyer *Biedovy*.

Admiral Togo says: "The above is the progress of the battle that continued from the afternoon of the 27th to the afternoon of the 28th of May. After this, part of the fleet searched for the enemy far to the south but no vessel was found. Of the Russian fleet of 38 vessels that attempted to pass the Sea of Japan, those that escaped destruction or capture are, we consider, only a few cruisers, destroyers, and special service ships; and our losses in these two days are only three torpedo boats. There are other vessels that received more or less damages, but none is disabled for future service. The total casualties are 116 killed and 538 wounded, officers and men all told."

THE FATE OF THE SEVERAL RUSSIAN SHIPS.

BATTLESHIPS.

Osliabia.—Head of left column. Was set on fire and sunk by gun-fire. Driven out of line in less than thirty minutes after battle began, floated thirty minutes longer. Sunk in about one hour after battle began by gun-fire.

Kniaz-Souvaroff.—Head of right column. Was set on fire before 2.45 p. m. Driven out of line in less than forty minutes after battle began, floated four hours and forty minutes longer. Sunk in five hours and fifteen minutes after battle began. Was isolated and had lost one mast and two funnels by 3.10 p. m. Attacked by destroyers at 3.40 p. m. and again at 4.45 p. m. One torpedo known to have hit in last attack. Listed ten degrees under this blow. Again attacked by destroyer flotilla attached to cruiser squadron, hit three times and sank at 7.20 p. m. 27th.

Alexander III.—Second of right column. Set on fire and sunk by gun-fire. Driven out of line in less than forty minutes after battle began, floated four hours and twenty-seven minutes longer. Capsized and sunk at 7.07 p. m. or five hours and two minutes after battle began.

Borodino.—Third of right column. Set on fire at 6.40 p. m. At 7.23 a serious explosion, probably magazines, took place and she sank instantly. Driven out of line in four hours and thirty minutes after battle began, floated forty-three minutes longer. Sunk in five hours and eighteen minutes after battle began.

Orel.—Fourth of right column. Surrendered morning of 28th to battle fleet. Unprotected and lightly protected parts wrecked by gun-fire. Heavy armor unpierced. Main turrets not seriously injured. No hits below the water-line. No torpedo hits. Engines intact. One 12-inch gun lost muzzle end.

Sissoi Veliki.—Second in left column. Torpedoed during night of 27th. Sank at 11.05 a. m. 28th.

Navarin.—Third in left column. Torpedoed. Hit once on starboard and once on port side. Sank at 2 p. m. 28th.

ARMORED CRUISER.

Admiral Nashimoff.—Fourth in left column. Torpedoed night of 27th. Sank at 10 a. m. 28th.

BATTLESHIP.

Nicholas I.—Nebogatoff's flagship. Followed the *Admiral Nashimoff* when in column. Surrendered morning of 28th.

COAST-DEFENSE SHIPS.

Admiral Oushakoff.—Second in Nebogatoff's division. Refused to surrender and was sunk by gun-fire about 5 p. m. 28th.

Admiral Senjavin.—Third in Nebogatoff's division. Surrendered morning of 28th.

Admiral Apraxin.—Fourth in Nebogatoff's division. Surrendered morning of 28th.

ARMORED CRUISERS.

Dmitri Donskoi.—Attacked by gun-fire and by torpedoes in the afternoon and evening of the 28th. Found sunk off Ullondo the morning of the 29th.

Vladimir Monomach.—Torpedoed in the night of the 27th. Sank at 10 a. m. the 28th.

CRUISERS.

Aurora, Oleg, and *Zemtchug.*—Escaped to Manila.

Almaz.—Escaped to Vladivostok.

Izumrud.—Escaped and wrecked in Vladimir Bay.

Svietlana.—Sunk in one hour by gun-fire from cruisers *Otawa* and *Nitaka.*

DESTROYERS.

Five sunk, one captured, two escaped.

To a naval officer the study of such a battle as this of the Sea of Japan is deeply interesting because of the deductions he may draw from the facts presented, confirming old theories or bringing forward new ones. It is better not to call these deductions lessons, for there are too many uncertain elements in any sea fight to allow the exactness of deduction from any one battle that should precede a lesson. Besides we have been so slow to take advantage of the many lessons that have been placed before us, that the very word has become discredited when used in discussing naval warfare.

After the battle of the Yalu the danger of woodwork on ships of war was frequently pointed out as a lesson gained from the experience of that fight. This was again insisted upon after the battles of Manila Bay and Santiago, and the lesson might well have been deduced many years before, as early as the battle of Navarino. Yet on May 27th much damage was done by woodwork igniting from exploding shells.

TRAINING.

The question of the amount of training necessary for men and officers is a most vital question. As the number of ships increases, the tendency is to place certain ships or a certain proportion of ships in reserve, with diminished crews, during peace. The necessity for more officers to man the increasing number of ships tends to the making of officers with less technical training; and the facility with which men are trained to shoot straight at targets, is tending toward the opinion that short training can make effective gun-pointers. In the discussion of this battle the advantage, yes the necessity of long and thorough training under proper conditions must be considered clearly proved, if it be admitted that the Japanese were not superior in force and that racial and political characteristics, as affecting their fighting qualities or capacity for training, were not greatly dissimilar.

By some writers the Japanese forces have been shown to be superior or equal to those of the Russians. This has been done by grouping intermediate with large-caliber guns and giving too high a weight to light armor.

There were not many, before May, who thought the Japanese could prevail against the united fleets of the Russians under Admiral Rodjestvenski; and these few expected the Japanese to succeed because of the poor training the Russians had received and because of the excellent training of the Japanese under war conditions. The Japanese were veterans, they had fought, seen their mistakes, and they had had time to correct many of their earlier errors and to supply some deficiencies. There was some talk of disaffection among the Russian crews, but long training would have eradicated it; and there is plenty of history to show that Russians make good fighters.

Admitted that the Japanese fleet, as ships, was not superior to the Russian fleet, and I believe they were inferior, then the overwhelming victory of the Japanese must have been due to the better training of the officers, which produced better handling of the ships, better tactics, better fire control, and also to the better training of the men which produced better shooting.

Admiral Freemantle says, in his account of the battle: "With reference to the accompanying table showing the material force of the two fleets, at first glance the imposing array of battleships in the Russian fleet with three coast-defense ships against four

Japanese, or five if the *Chenyen* is included, make the Russian fleet appear much superior; but the Japanese had eight powerful armored cruisers against three old Russian armored cruisers, which more than redressed the balance, while in numbers of protected cruisers and in torpedo craft they were immeasurably superior. A modern armored cruiser is a battleship in disguise, and a careful calculation of force made in accordance with Mr. Janes' scale, which takes no note of unprotected cruisers or torpedo craft, shows that the Japanese force was as 11.6 to the Russian 9.2. Thus the Japanese were actually stronger on paper; but this does not nearly represent the real facts in the case, for the four first-class battleships and eight armored cruisers formed a homogeneous force of good speed capable of acting together, and accustomed to acting in concert, while of Rodjestvenski's fleet even the eight battleships were of different speed and date, and the coast-defense ships were simply a drag on him, adding far more to his anxieties than to his strength. While Nebogatoff's squadron had been only a few days with the Commander-in-Chief, when, on the 14th of May, the armada, consisting, it is said, of eighty ships sailed out of Kamranh Bay."[4]

The *Chenyen* should be excluded from any account of the strength, when the measure is the effect in actual battle, as she was not brought into the line. In the same way the cruisers and torpedo craft may be ignored under like ruling, for while most valuable before and after the battle, their presence had no weight in the actual conflict.

The *Souvaroff*, *Alexander III*, *Borodino*, and *Orel* were all of the same type and completed at the same time. In all except speed, in which they were slightly inferior, they were equal if not superior to the Japanese. Their protection was probably a little stronger than the Japanese and they had from one knot to three-tenths of a knot less speed, and two less intermediate-caliber guns than the *Mikasa*, *Asahi*, and *Shikishima* and two more than the *Fuji*. Except for loss of speed due to long time out of dock, the four battleships of the Russian right column should have been the equal if not the superior of the four Japanese, if handled by equally well-trained officers and men. That the speed was not a vital point in the actual conflict it is proposed to show later.

[4] The Japanese Trafalgar. By Admiral the Hon. Sir E. R. Freemantle, G. C. B., United Service Magazine.

The remaining four Russian battleships varied in size from the *Osliabia* of 12,674 tons to the *Nicholas I* of 9762 tons. With the three coast-defense ships they were certainly a match for the eight Japanese armored cruisers. They had ten 12-inch guns, seven 10-inch, and twelve 9-inch against the Japanese thirty 8-inch and one 10-inch. Their protection was generally better than that of the Japanese but their speed was much less.

The three Russian armored cruisers are ignored in this count of strength as they were very weak.

The speed of the entire Russian fleet was cut down to that of the slowest ship; but while this was a great detriment in many ways it could have had little effect on the battle at its crucial period provided the slow vessels were handled properly. Although the lowest Japanese speed was greater than the highest Russian, there was greater difference between the slowest and fastest Japanese ships than there was in the Russian.

It is true that the Japanese ships "were capable of acting together and accustomed to acting in concert," but this was a matter of training both in peace drills and under war conditions. Both in this battle and in that of August 10th off Port Arthur, the various divisions of the Japanese fleet were handled with great skill, and when maneuvered separately or in squadrons or divisions, co-operated harmoniously as one fleet. Only constant exercise in drill tactics and battle tactics and with officers and men who had an aptitude for seamanship could such precision be reached.

But the Japanese gun practice in the battle of August 10th was far from good. While the reported ranges were very great and much of the shooting must have been a matter of chance, there were times when the distance was not great and then the hits were few. The firing was very rapid and there were little or no signs of fire control. On May 27th the gun practice was far better; and the hits were numerous when the ships were within spotting distance. The fire control had been greatly improved.

The Japanese officers were trained to handle their ships and to direct their guns; and the men were trained to make hits, to steer, and to run their engines. They had worked together under the same Admiral. They were a tried and well-balanced weapon in the hands of an experienced and resourceful man. The Russian officers and men had little training and their Admiral had had

little opportunity to exercise or drill them. It was not the difference in the ships, in their guns, in their protection, or in their speed; but the difference in their training that caused some to feel confident they would hear of a Japanese success when the meeting of the fleets was first cabled.

STRATEGY.

The strategy adopted by the Russians appears to have been sound in principle. They needed the command of the Sea of Japan and of the adjacent waters. At least they must disturb the uninterrupted command of the sea held, in those waters, by the Japanese since the fall of Port Arthur. Their only base within reasonable distance, for continuous operations, was Vladivostok, so that the initial step to be taken was to reach that port, with as large a force as possible, and without a contest with the Japanese fleet, if practicable, unless able to take them at a disadvantage. It might have been practicable to have seized a temporary base nearer the area of action, but then they would have been without the very necessary docking and repairing facilities and supplies would have been a great difficulty.

The junction of Rodjestvenski's squadron with that of Nebogatoff's was probably wise. While the latter squadron added nothing to the strength of the fleet for immediate action, in fact it was a possible source of weakness, numbers would become important when attempting to destroy or interrupt Japan's freedom of intercourse with her home bases. The armored ships of Nebogatoff's squadron should have formed a protecting force for colliers and special service ships, in fact made a floating base with strength enough to beat off anything but an attack in force and sufficiently mobile to follow their battle fleet and not to hamper its movements during battle.

The time while waiting for the junction was utilized in preparing for the contest and the route chosen was direct and reasonable. The whole affair of conducting this large fleet of vessels to such a distance from the home bases was a feat in logistics most creditable to Admiral Rodjestvenski.

The necessities of the case required the Japanese to strike the Russian fleet before it reached Vladivostok. Should that port have been reached by the Russian fleet the Japanese communica-

tions would have been liable to dangerous interruptions as the fleet was too large for the comparatively small Japanese force to blockade with success. The question was when and where should they strike their enemy.

Admiral Togo held his entire force concentrated near the entrance to Tsushima Straits and near his home bases. This was at a point sufficiently constricted to prevent a passage of the Russian fleet without his knowledge and there he waited patiently. As it would have been possible for the principal ships of the Russian fleet to pass through either Tsugaru or through La Perouse Straits, Admiral Togo must have had some anxious moments as he held the passage of Tsushima, for the Russians delayed their movements so as to give rise to the opinion that they were passing outside of Japan, and the Japanese scouts had lost touch with their enemy. So that although holding interior lines, it was possible for the Japanese fleet to arrive too late at the other straits. Admiral Togo must have reasoned that as Admiral Rodjestvenski had waited for the arrival of Admiral Nebogatoff's squadron, he was not going to desert it close to its enemy's home bases; and Admiral Nebogatoff's squadron had too small a steaming radius to attempt to steam around Japan.

Admiral Togo had wisely judged the point where his enemy would pass and had carefully gauged his strength. Many thought he would strike the Russians at an earlier point in the voyage with his armored cruisers and destroyers, thus attempting to weaken the Russian battleship force before striking with his own battleships. The Russians had eight battleships, seven fit to fight in the line against the four Japanese, and by constantly harassing the Russian fleet, after dark, with armored cruisers and destroyers some of the odds might have been diminished. When the Russians entered the Passage seas and again before they passed Formosa it was expected that the Japanese would attack with the idea of sacrificing the lighter ships in hopes of lessening the task of the four battleships. With a better trained foe this would have been necessary, for the greater speed and size of the Japanese would not have been sufficient to have outbalanced the three additional battleships of the Russians and with reasonably accurate shooting the armored cruisers of the Japanese would have been driven from the line and it would have been a contest of sixteen 12-inch guns against the Russians' twenty-eight.

TACTICS.

Admiral Togo used certain of his auxiliary cruisers as his outer line of scouts. With their speed and large steaming radius and with their wireless outfit, they were admirably fitted for this purpose. His inner line of scouts was formed by a squadron of protected cruisers and one or two flotillas of destroyers, supported by the *Fuso* and *Chenyen*. The charts of the adjacent waters was divided into squares for convenience in signalling the positions of the ships of either fleet.

The Japanese appear to have lost touch of the Russian fleet after its passage south of Formosa until reported by the scout *Shinano Maru*. From that time on Admiral Togo's information was complete and reliable.

The secret of the whereabouts of the Japanese fleet was admirably kept. How it was kept from foreigners, who would have cabled some clue of their information, is difficult to imagine.

The Russians appear to have had no scouts out on the morning of the 27th and to have made no attempt to interrupt the Japanese wireless communications. Surely they could have confused the Japanese messages unless the latter have discovered the art of synchronizing beyond the knowledge of other nations. With five fast cruisers, backed up by three rather slow armored cruisers something might have been attempted, by the way of scouting, to drive in the Japanese scouts and to prevent them from sighting the battle fleet. The fast Russian cruisers might have driven off the Japanese auxiliary cruisers. Because of their weak armament they could not cope with the Japanese protected cruisers; but when these were sighted the Russians might have brought up their armored cruisers and driven back the Japanese. Even then some of the fast cruisers of the Japanese might have been able to press in close enough to sight the battle fleet; but had their wireless messages been interrupted or confused, Admiral Togo's information would have been incomplete and it might have been possible for the Russians to have escaped an immediate attack in the mist. The Japanese advantage in speed was too great to give much chance of the Russians escaping to Vladivostok without a fight as the speed of the Russian fleet by this time was reduced by foul bottoms, etc., to between ten and twelve knots. But on the eve of battle even the strongest should neglect no chance, should relinquish no advantage.

Admiral Togo was in no doubt as to the tactics to be adopted for the battle. The various phases must have been discussed with the many admirals under his command and by them with their captains and the battle tactics had been well tried until all were familiar with their duties.

"The plan which Admiral Togo had formed to annihilate the enemy's fleet, extended over four days and nights, commencing the operations near Quelpart and continuing them to the front of Vladivostok. This plan was divided into seven stages, the first two of which we were not enabled to carry out on account of rough weather, etc. The battle was opened with the third stage, followed by the fourth and fifth stages, and terminated before we entered on the sixth stage, so that we did not execute the last two. The third stage was the regular attack of the enemy with our whole forces; the fourth stage was the torpedo attacks by the whole of our destroyer and torpedo-boat flotillas, which began at sunset the same day when the regular attack had been finished; and the fifth stage was the attack made against the remnants of the enemy's ships by the greater part of the fleet on the line east and west of Dagelet Island, our vessels having proceeded there before the enemy and lying in wait for him. Thus, as is taught in the old tactical maxim, we met the enemy in the regular order of battle and defeated him by using stratagems such as flank attacks, torpedo attacks, etc., and there was nothing new in our tactics."[1]

Admiral Togo's plan of battle tactics was to attack the head of the Russian fleet with all his armored vessels, his battleships leading. The Russians being in double column he maneuvered so as to T. them and as they deployed into an irregular single column on a line of bearing parallel to his, he used his greater speed so as to overlap their head and to concentrate his fire on their leading ships.

The two Japanese squadrons, Admiral Togo's leading, worked together harmoniously, and when the Russians countermarched the Japanese battleship squadron was kept in the lead by a beautiful maneuver; but it is more than questionable whether the policy of extending their line of battle with the armored cruisers would have been successful with a well-trained enemy. As it was, only

[1] A staff officer of the combined fleet on the Battle of the Sea of Japan.

one of the armored cruisers was damaged, while their fire served to disturb the aim of the pointers on the Russian battleships and to destroy some of the defenses of the ships against torpedo craft. With an enemy whose officers and gunners were well trained the armored cruisers would have been soon destroyed or driven off without being able to inflict any serious damage on the battleships; for only one Japanese armored cruiser carried guns above 8-inch caliber and their fire could be effective only against light armor.

"Our navy showed great excellence in gunnery, but at the same time we must not forget that the tactics adopted by Admiral Togo and Vice-Admirals Kataoka, Kamamura, Dewa, and Uriu were also adapted to the occasion, for, however skillful our ships were in gunnery, unless they were maneuvered well, their skill could not be brought into full play. Thus the tactics of the day was a main factor of winning the victory. The tactics planned by Admiral Togo beforehand were what are called in our navy tei (T) and otsu (V) orders of battle. These are nothing new. I do not know of Europe and America, but they have been used in our country from several hundred years ago. On that day Admiral Togo operated so as to press the head of the enemy and draw the character T as is shown in the diagram. Thus the fire of our whole column was concentrated upon the head of the enemy before his last ships came up to firing distance."[8]

Bad tactics handicapped the Russian fleet in the beginning of the battle. It must be recognized that the Russian fleet was slow, its best speed during the battle could not have been over twelve knots while the Japanese must have been able to steam continuously at least fifteen knots. There was all the more reason for so maneuvering the fleet as to prevent its being capped by the Japanese. Had the Russian battleships been in line or in column it would have been impossible for Admiral Togo to have completed the T. Even as they were, in double column, had the fleet been deployed at once, Admiral Togo would not have gained this great advantage. The coast-defense ships should have been left to guard the special service vessels and the battle fought out with the battleships.

When the fleet was deployed and steaming in parallel columns the Russians, as the slow fleet, should have turned away from the

[8] A staff officer of the combined fleet on the Battle of the Sea of Japan.

Japanese and by moving over the shorter inner circle kept abreast the head of the Japanese column. If Admiral Togo kept at about four thousand yards distance and steamed at the rate of fifteen knots, the Russians steaming only ten knots could have kept from being overlapped by steaming on the circumference of a circle with a radius of four miles. If the distance was three thousand yards the radius should have been three miles. Speed is most valuable, but the slow fleet can prevent overlapping, if properly handled, unless the leading ship is unable to steer.

It is important to notice that the Japanese did not open fire until within seven thousand yards, and as the two fleets were converging, the range decreased rapidly. The range for the battleships at the head of the column must have been quite short much of the time, and on one occasion at least they were near enough to fire torpedoes from the Japanese battleships. Now that a decisive conflict could be risked the Japanese no longer kept at great ranges and fired rapidly without discrimination. In this battle they used ranges where their knowledge of fire control and skill in straight shooting would prove useful and only fired rapidly when they could see they were hitting. Evidently they had little faith in the chances of long-range shooting so much extolled after the battle of August 10th. The Russians in their reports speak frequently of the splendid shooting of the Japanese at very long ranges; but they must have magnified distances, looking at the Japanese ships in war paint through a mist.

Most of the accounts of the battle state that the Japanese had replaced nearly all of their 12-inch guns after the battle of August 10th. Mr. Wilson suggests that they had a reserve of four guns for each battleship. This hardly seems possible unless the resources of their ally was counted upon as part of their reserve. It is quite certain that many of the heavy guns were replaced before May 27th, and this points to the necessity of our having a large reserve of guns. The English have maintained a reserve of one big gun for each battleship; but after the experience of this war their reserve will probably be increased.

The Japanese appear to have used common shell with a large bursting charge of high explosive. These shells frequently exploded at the moment of contact and therefore their effect was comparatively small. The fuses or bursting charges were too sensitive and greater damage would have resulted to the structural

strength of the ships had black powder been used for bursting charges. The vessels that were sunk were first set on fire but there is nothing to show that the Shimose powder is better adapted for this purpose than black powder. In fact in all our experiments the advantage has been with the latter.

How the vessels were sunk when their sinking was due to gun-fire remains uncertain. The Japanese ascribe it to hits above the heavy armor belt, which was little, if any, above the water owing to the heavy load of coal and stores carried by the Russian vessels.

The *Alexander III* floated about four hours and thirty minutes after the battle commenced and then capsized. This was due probably to hits above armor belt. The *Borodino* floated four hours and thirty minutes after the battle began and was sunk by the explosion of the magazine. The *Admiral Oushakoff* was sunk by gun-fire in a very few minutes. It has been suggested that her sea valves were opened and the vessel allowed to sink rather than to surrender or to continue the fight. The *Osliabia* was sunk in about one hour after the battle began; whereas the *Kniaz-Souvaroff*, which was also set on fire and driven out of line, floated for over five hours although struck by torpedoes two hours before she sank.

SPEED.

The question of speed in battleships has been much debated and lately some English writers, notably Sir Cyprian Bridge and Rear-Admiral Custance, have decried its value. This is due more to the fear of sacrificing other more valuable qualities to speed than to a close study of its advantages strategically and tactically. It is true that the slower fleet can avoid being overlapped by the faster, by using the inner circle, but this must be done just right without mistakes or accidents and battles are won by taking advantage of the mistakes and accidents of the enemy. Surely none of the English officers who have had the opportunity to participate frequently in the P. Z. exercises would fail to recognize the advantages of superior speed. Of course if there is no advantage gained in capping a column or drawing past the flank of an enemy, thus concentrating the fire of the fleet on one or two of his vessels, then speed is of little value in actual battle, but no point is more clearly shown forth by the Battle of the Sea of Japan than the fact that capping the column and holding the key is of supreme value.

The *Osliabia* was set on fire and driven out of the line as the four Japanese battleships headed the Russian columns. Then as they passed along ahead of the right column the *Souvaroff* was driven out of line, and continuing as they steamed to the southward and westward around the head of the column, the second in line, the *Alexander III,* was dropped. Then the third in line, the *Borodino,* was set on fire and sunk later in the afternoon. The *Orel,* the fourth vessel in the right column, was the only vessel of that column to escape destruction by gun-fire and she was pretty well smashed up.

Of the vessels following the *Orel,* after the irregular column was formed, the *Sissoi Veliki* and *Admiral Nashimoff* were torpedoed on the night of the 27th. The *Navarin* on the 28th. In fact ships were damaged very nearly in proportion to their distance from the head of the column, and one after the other, by the concentrated fire of the four Japanese battleships. Those in the rear that did not suffer by this concentration and were only subject to long-range firing from the armored cruiser squadron were sunk by torpedoes or forced to surrender the next day by the Japanese battleship squadron, this, with the exception of the *Oushakoff,* which vessel refused to surrender and was sunk by gun-fire and possibly by friendly hands.

Does not this prove the advantage of speed? It may be argued that had the Russians deployed before sighting the Japanese the advantage of speed would not have been so apparent. This is true, and had they used the inner circle and fired straight the battle would have had other ending; but, as it was, speed helped the Japanese to hit a hard blow in the beginning and make the battle a decisive one.

BIG BATTLESHIPS WITH ALL BIG GUNS.

The displacement of our battleships, like those of other naval powers, has been steadily increasing and increased displacement has had many logical opponents, for sometimes the increased size has brought greater cost without commensurate increase in power. Neglecting the *Maine* and *Texas,* as they were experiments and not over successful ones, our first type of battleship was of ten thousand tons and this has been increased to thirteen and now to sixteen thousand tons. The first type, the *Indiana* class, carried four heavy guns, and the last type carry the same number. Now

there have been many improvements in guns, armor, and equipments that make the latest type much stronger than the first, but we are considering increase in size only. The first increase in size gave a large increase in the intermediate battery and introduced intermediate armor. In the next increase in size, the *Maine* class, there is again an increase in battery power and a valuable gain in speed. In the last type there is a gain in intermediate battery power; but there are not many who now believe that the gain in power of a *Connecticut* over a modern ship of similar design to the *Iowa* is sufficient to pay for increased cost of construction and maintenance. Many have claimed that more units were better than a few large vessels, and this claim was not difficult to sustain when the small battleships carried the same number of big guns as the larger ones.

The introduction of the intermediate battery was logical, as at the time it was developed the primary battery guns were very slow in firing and extremely slow in hitting. With insecure sights and brown powder, turret guns were not instruments of precision. As there were large areas of the ships that were either lightly armored or unarmored, the intermediate rapid-fire guns were introduced for they had sufficient power to injure the personnel and even to diminish, to a large degree, the efficiency of the ship by the destruction of the soft ends. Then came more light armor to protect the intermediate battery with the necessary increase in displacement.

Since we have been developing larger battleships the power of hitting with the big guns has been increasing by leaps and bounds. All ordnance material has improved and the training of officers and men has become scientific. Now the heaviest gun can be fired as rapidly as the intermediate guns could be fired formerly and with them they can make more hits than the lighter guns could make in earlier times. The old theories of "a smothering fire" and "a greater number of units" must be allowed to die; as one or two hits from the big guns can destroy soft ends and wreck weak battery spaces, and such guns only are able to attack the life of a ship. Look at the *Orel!* What use is there in having a large intermediate battery if its power is destroyed before the ship can come into the effective range of the lighter gun. Light armor, which affords sufficient protection against light guns, but adds to the destructive effect of the heavier shells, and lightly armored batteries become death traps.

If other nations have greater speed we must follow, if we will not lead, and with higher speed comes greater displacement and more room for large guns. A division of large fast ships carrying all large guns, as of the new English type of about eighteen thousand tons trial displacement with ten or twelve 12-inch guns and making over twenty knots, would be a most formidable antagonist for a squadron of the largest and finest battleships now afloat or nearing completion. The four ships would carry forty-eight 12-inch guns on seventy-two thousand tons displacement, while the eight smaller ships would carry only thirty-two 12-inch on one hundred and twenty-eight thousand tons; or one thousand five hundred tons to each 12-inch gun in the larger ship to four thousand tons to each 12-inch gun in the smaller; and the cost per ton would be smaller in the larger battleship.

The English are starting to build a large ship with all big guns and expect to complete it in eighteen months. The Japanese have started two big ships and France and Germany are said to be following suit. The German press is agitating constantly for large ships. By all it is taken to be the clearest lesson to be obtained from the Japanese success at sea. Count E. Reventlow says: "What is a ship of the *Deutschland* class, for instance, to do against a *Dreadnought?* She would be in about the same position as the Russian cruiser *Variag* and the old *Koriets* in the presence of the Japanese armored cruisers at Chemulpo. The *Variag* had one advantage, which on the open sea might have been her salvation, and that is superior speed. The German ships would not have even that, for the battleships of larger displacement, especially the English ones, develop unexcelled speed. To go down honorably is certainly a fine thing, but after all that is not what battle fleets are built for."

The greater effective range of the larger caliber guns is also important, the smaller guns and their protection can be put out of action before they can be fired effectively and the low trajectory of the larger guns is still more valuable. There is little chance of knowing the range of an enemy with sufficient accuracy to make a hit if his distance is over five thousand yards; and if known accurately the right height of the sight bar for the powder used may not be exactly known. There are also many chances of making lateral errors. With untrained crews it may be well to keep at long range and trust to chance shots; but with trained

crews the range should be such that the fire can be controlled and every advantage taken of the low trajectory with little left to chance. The distance at which the Russians report that the Japanese opened fire is certainly exaggerated, and their extreme accuracy at great distances is impossible unless they have discovered some wonderful range finder and have powder of far more uniform velocities than any known to other nations. The inside limit of range is generally accepted to be the extreme range of the torpedo, but there was nothing in this battle to prove that this limit is necessary.

There is one deduction from the experience gained in this war that appears to have been made by nearly all students of naval battles. The necessity for larger battleships is acknowledged to be clearly shown. When Admiral Dewey's interview in the New York *Herald* appeared, it was welcomed with applause by all except one or two who have been in strong opposition to those at present in authority over the navy of Great Britain.

There are other deductions that may be drawn but cannot be said to be so clearly proven by this war alone. Yet when it is studied in connection with other naval wars the situation becomes clearer and the evidence points one way. Such as the necessity for long and careful training of both officers and men and the requirement that the officers should have sufficient youth and vigor to stand long extended strains. That they should hold flag rank long enough to gain experience in handling divisions, squadrons, and fleets. There were twelve flag officers, including Admiral Togo, all comparatively young, with the Japanese fleet.

Big ships with big guns are necessary to success; but the personal element is as important to-day as it always has been, and without a well-trained crew guided by well-trained officers a big ship with its big guns is a waste product and a big fleet may expect defeat.

Since the battles of August 10th and May 27th few will claim that signals are impracticable or that the decisive moment of the combat is the melee. Speed in the ships, speed in making combinations, speed in making signals, and above all speed in making hits win victories.

It may not be amiss to end these deductions with the moral drawn from the battle by an English layman: "For here, surely, is the point that touches each one of us. Ships and the art of

war are for the professional; but the men who direct and man them are our affair too. The men we know and understand, for they are of our own household. We are ready enough to see that they are provided with weapons and engines of war; that is easy; it costs no trouble beyond the signing of a cheque. But, that is to place the last first, and the first last. The fight of the Sea of Japan, if it proves anything, proves the inestimable and prime importance of the man as distinguished from his weapon. Here, then, is the principle for which we have been looking—the principle that brings the maintenance of sea-power into direct relation to the layman. It is for us, each one of us, to see that the right men are provided, that their training is not stinted for lack of money. No system or organization will serve. These things must be the individual concern of every man.

"A fervent spirit, together with a minute and unsleeping vigilance, has won for Japan the command of the sea, and a high place among the nations. That is the meaning for the layman of the Battle of the Sea of Japan."[1]

It remains but to mention the guiding power of all the machinery that produced this complete success, the General Staff of the Japanese Navy. To them belongs the credit of long study and thorough preparation. They designed and constructed the machine that was handled with consummate ability by Admiral Togo. A General Staff exists in some form in all military bodies, it must work silently, it can only prepare; but without it even the genius of a Nelson or a Togo may fail to achieve victory.

[1] The Battle of the Sea of Japan, L. Cope Cornford. The Monthly Review, July, 1905.

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WHY TOGO WON.

By COMMANDER BRADLEY A. FISKE, U. S. Navy.

The accounts that we read of the final naval battle between the Japanese and Russians are so meager that one may easily become confused if he tries to make out exactly what things happened, and the succession in which they happened. Most accounts seem to show, however, that the two following conditions existed:

1. The two forces were so nearly equal in material, that whatever difference there was may be neglected in this inquiry.

2. The two forces were so nearly equal in bravery, that whatever difference there was may be neglected in this inquiry.

The cause of Togo's victory, therefore, was not the superiority of his forces in material or bravery. What was it?

Two causes stand out plainly:

1. The Japanese fleet handling was better than the Russian.

2. The Japanese gunnery was better than the Russian.

Of these two causes, it is clearly impossible to decide which was the more important. Good gunnery is of little use, unless the fleet handling be so skillful as to keep many guns bearing on the enemy; and good fleet handling is of little use, unless the guns which it keeps bearing on the enemy are accurately fired. Fortunately, it is not necessary to decide which of the two was the more important, because excellence in either is not gotten at the expense of excellence in the other.

The fact that the Japanese excelled the Russians in both fleet handling and in gunnery, combined with the fact that the contestants were practically equal in material and in bravery, seems to explain Togo's victory so completely that the stating of it as a cause seems like the stating of a platitude. But platitudes have

sometimes a great advantage over more interesting statements,—the advantage of being true.

But, even if the better fleet handling and gunnery of the Japanese be accepted as the causes of Togo's victory, it may be well to remind ourselves that they were the immediate causes, and that immediate causes are often intermediate causes;—the mere results of more important causes.

We may now seek, therefore, for the causes which made the Japanese fleet handling and gunnery better than the Russian fleet handling and gunnery.

A comparison of the two fleets shows us at once two important points of difference:

1. The Russians went into battle for the first time. The Japanese had been in battle on August 10, only ten months before; and many of the officers and crews had served in the war with China, ten years before.

2. The Japanese fleet had been in existence longer than the Russian fleet, and had, therefore, been drilled longer as a fleet.

Probably nine men in ten would declare, at once, that, of these two factors, actual experience in battle was the more important, in preparing the Japanese for battle.

But why is experience in battle a better preparation for battle than mere drill in peace? What is the definite reason?

Is it not simply because drill in peace is lacking in certain elements of realism? Is it not because mere drill is, at the best, an imitation? Is it not because the best way to prepare for any performance is to rehearse it, under conditions as close as possible to the conditions under which the performance will eventually be given?

Of course it is. In Togo's case, however, even the maneuvers and drills of his fleet during several months before the final battle were held under the conditions of absolute war, and, therefore, under conditions of the most intense realism. This realism could not fail to give definiteness to the maneuvers and drills, and to inspire in every man that genuine interest which every man feels in what is really real.

It may be stated, therefore, that Togo won because he and his fleet had been trained under conditions which were more realistic than those under which the Russian admiral and his fleet had been trained; and that the result of the battle, though infinitely

more important than the victory of a properly trained foot-ball team over an improperly trained foot-ball team, rested on the same principles, and could have been as easily predicted, had the facts been known.

Now human nature is so selfish that the past has little interest for us, unless we can find in it some guidance for our own future.

If Togo won because he and his fleet had been prepared for battle by experiences more realistic than the experiences which the Russian fleet had had, does this not guide us to the conclusion that our own drills and maneuvers should be made as realistic, as much like battle, as possible?

If so, does it not follow that every element should be introduced into our drills and maneuvers that can make them more realistic? And does it not also follow that every contrary element should be left out—every element of mere show, prettiness, and spectacularism?

Furthermore, since the naval profession has become a profession rapidly expanding, a profession in which an increasing amount of time is needed for study, thought, discussion, and observation, does it not also follow that every useless custom, ceremony, and piece of uniform should be discarded;—to the end that the work of every man, like the work of every well-regulated engine, shall be economically expended, and as little as possible frittered away in "losses"?

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DESERTIONS IN THE NAVY.

A CONTRIBUTION TO THE DISCUSSION OF THE QUESTION.

By Rear-Admiral Caspar F. Goodrich, U. S. Navy.

When the late Rear-Admiral Taylor was announced as the President's selection for the position of Chief of the Bureau of Navigation I wrote to him, offering to utilize the opportunities I enjoyed as captain of a receiving ship, to which stragglers and deserters were being brought every day, to interrogate them confidentally and to obtain in each case, if possible, the true reason for the desertion. That some of these returned wanderers would lie consumedly, I perceived; yet, out of the body of evidence thus eventually elicited, I hoped to draw some sound conclusions upon which the department might base remedial measures, if such should prove necessary or desirable. It seemed to me that facts were imperatively demanded and that we had been too long content with theories and speculations. It would have been a thankless task, I stated in my letter, to undertake the accumulation of this testimony without assurance in advance that it would be welcomed by the bureau. If they were desired, I placed my services at its disposition feeling confident that they would yield some slight good to the navy. The reply I received was very disheartening, when considered on personal grounds, but most encouraging from the service point of view. It told me, substantially, that desertion was well understood as caused by the restlessness of youth and a desire for change, and it added kindly that there was no objection to my pursuing, if I liked, the investigation I had proposed, although it promised to produce scanty results and little benefit. In other words, the fault was held to exist in human nature, which is immutable, and not in naval conditions, which may be changed—unquestionably a most comforting deduction.

It is needless to say that I promptly abandoned my work of

supererogation, regretting my folly in supposing for a moment that a ray of light might be welcome from any source, however obscure.

The episode goes to show that for a long time past I have believed desertion to be a complex sociological problem demanding painstaking study from all sides, especially from inside, before its solution can be reached. While something may be attributed to the wayward and fickle impulses of adolescence as leading men into the temptation to desert, it would seem as if that something should be left as an "irreducible minimum" after all other operating reasons have been eliminated.

Having conferred with many persons on the subject, I venture to place before the Naval Institute and the naval service some suggestions, or, rather, heads of discourse drawn almost entirely from the wisdom and experience of my colleagues. My own share is so slight that I may only claim credit if I present fairly and clearly the notions and opinions of others and thus provoke a discussion which shall bear fruit in lessening this evil, if it is an evil at all, and if, furthermore, it is capable of elimination in whole or in part.

I.

It is believed by some, doubtless erroneously, that the hardships and deprivations of the sailor's life are not dwelt upon by recruiting officers with as much frankness and in as much detail as the benefits and pleasures, so that recruits are disappointed when confronted with actual conditions on board ship. Personally, I have never administered the oath which seals enlistment without making sure that the candidate was well informed of the disagreeable things he would have to encounter. I could not, in justice to myself, incur the risk of being, if only tacitly, subsequently accused of deception through suppressing or glossing over the less attractive feature of life afloat. To describe the naval career as one prolonged yachting trip to "the four quarters of the globe" and not to tell of the principal restrictions imposed by the ship's discipline is to invite ultimate condemnation by a recruit who has enlisted under a misconception.

II.

Can it be true that a man is shipped, say, as a "coal passer for oiler" under the belief that he is to receive the advance in rating

on joining a cruising ship, only to have that belief shattered by subsequent refusal to promote him? And if there be such cases, are not the disappointed sufferers likely to consider themselves morally, if not technically, free to quit the service which, having made a contract with them, proceeds, in their eyes, to break that contract at its pleasure while rigidly holding them to fulfilment, even going so far as recourse to criminal proceedings?

III.

Do not officers in charge of recruiting parties feel under heavy pressure to secure the largest possible number of recruits in a given time? And adjusting their activities to this requirement, are they not, in self defence, lest they be judged less efficient than their rivals, compelled to enlist all whom they can engage and who can squeeze through the prescribed examination? If these gentlemen are publicly graded according to the quantity of their work with no regard to its quality can they be reasonably expected to discriminate between Thomas and Richard and Henry? Will they not enter all three and be thankful?

IV.

It has been suggested that a recruiting officer's standing among his fellows ought to depend upon two things—first, the *actual* number of his enlistments still in the service after two years from the date of taking the oath; second, upon the *percentage* of his enlistments so remaining. A combination of these two elements might result in rewarding some good fellow who has already lost, in the race of numbers taken in, because he would not accept undesirable offerings. That he has done well by the navy even at much personal sacrifice cannot be denied.

V.

There can be little doubt that things have not improved through some of the changes in the law of enlistments. The enlistment for special service for short terms worked exceedingly well. It was elastic, a great advantage, and it was optional on the part of the department. Why it was forbidden by law at the request of those in authority at that time is difficult to understand. To possess a power and not exercise it is one thing—but to deliberately

draft a bill to prohibit your own exercise of this power is another. The latter would be amusing were not the consequences so serious.

VI.

Can it be shown that any gain has been made by changing the term from three to four years? The assumed benefit was very clear. A man was to join a ship on her commissioning, serve out his whole period on board of her and get his discharge after her pennant was hauled down. A beautiful theory of no earthly application whatsoever, for ships never go out of commission now-a-days until so run down that a new birth is imperative. Or, a man might go to China and similarly make a traditional three-years' cruise on one ship—as if it took a year to get a man out to Asia and back. Sometimes we appear to hold firmly to a tradition when the tradition is futile and again to depart from it when really valuable.

That many good men shy at binding themselves for four years, while ready to engage for three, is believed by some officers. Personally I can sympathize with the machinist, for example, who would like to make a cruise, is willing to enlist for three years, even though they loom ahead of him as a frightfully large slice out of his life, but who finds in a four-years' engagement an eternity, a blank wall, an insuperable obstacle.

Why not endeavor to ascertain the advantages and disadvantages of each term, tabulate them, weigh them, and reach a conclusion based as far as possible on facts rather than on individual opinions? Possibly this has already been done.

VII.

That desertions are more frequent during the first year or so of enlistment than later may be easily proved if the fact be not admitted as established. There is nothing which should astonish us in this phenomenon. In spite of everything which the most conscientious recruiting officer may say about the navy, the recruit is certain to have, in his mind, certain illusions—to "se faire des images" as Napoleon was wont to express it—and be more or less disappointed when later his images are shattered. Then he realizes the awful fact that he is committed for four years and he thinks any means of escape permissible. Discharge by purchase, which formerly provided an honorable method of exit, is

unfortunately abolished. There are three things he may do—stick it out, desert, or die. Some stick it out; some, persuading themselves but too easily that death is inevitable, if they stay, desert; others, risking the chances of capture by the police and of subsequent punishment, desert out of hand.

Now each desertion means not only the loss of a man but also the loss of a lot of money and time invested in his instruction. Of the two losses the latter is probably the more important.

Even if the term were lowered to three years, it is not likely that this cause of desertion would become notably less productive. To a young man of twenty-one, three years are not so much one-seventh of his life as they are practically the whole of his life since attaining physical manhood. To their elders, whose eyes run over many lustra, three years assume their true perspective, but not to the impatient vision of youth. Moral principle, sworn obligation, both disappear in the comparison and the unhappy fellow seeks relief in an act which lands him eventually in the prison ship.

I have heard it said that the influences of the navy appear more active in inducing a man to enlist than in keeping him in the service, useful, contented, and ambitious, after he is caught. Personally I do not think so, but such a view must be held by some of the newcomers or there would be fewer desertions. I have also heard it proposed to give the recruit smaller pay during the first year; at its expiration to offer him the privilege of discharge or of remaining another year and of receiving a money bonus for so doing (an increase in monthly wage is usually advocated); at the expiration of the second and third years, similar privileges; at the end of the full term, an honorable discharge, if duly earned. On the second and subsequent enlistments, the entry would be for the full period since the applicant knows the navy and engages of his own free will, aware of the drawbacks and of the rewards.

Impossible! Too much bother! Too costly! Why?

Surely no one familiar with the volume of summary and general court-martial records in desertion cases which bank up annually in the office of the Judge-Advocate General or with the time consumed, ashore and afloat, by the trials themselves will admit that any method leading to their reduction can be of too much bother. If an executive order can be framed to cover the privileges just mentioned, then the thing is not impossible. Far from being costly, it would probably save money. A man claiming his dis-

charge at the end of the year would be content to receive it at any port in the United States; at the end of any subsequent year to pay his own way home, if discharged abroad. So much for the item of transportation. All these and other matters should be "nominated in the bond" and a man should have a copy of his contract, if he desires. It would be interesting to contrast the losses by such discharges with those now occasioned by desertion. There are some officers who think the former would not greatly exceed the latter, and some enthusiasts who think they would be less.

VIII.

I have been told by those in a position to know that the most fertile source of discontent on board ship is the "monthly money." How many men, on enlisting are told that, although awarded so many dollars a month for their labor, they can only touch such portion of their pay as may be allowed them by the commanding officer under the navy regulations? If recruits before signing were told that fact, what proportion would refuse to take the oath? What would Congress do if it were informed that the funds it appropriates to pay our seamen are held up and only completely given out at the end of the four-years' enlistment?

I blame no one, not even myself, who have also done this thing. It is a tradition—a custom which has come down to us from the days of Benbow—but none the less one may wonder whether it is just, and if just, whether it is wise.

That a certain sum should be kept on the books for emergencies, everyone will concede, but beyond that why not pay Jack what he earns each month? Encourage him to frugality, preach the benefit of deposits at four per cent; both are right, but why deny him his wages when fairly earned? This is what some persons urge.

An officer who has paid great attention to this subject and whose opinion I regard as unusually valuable writes me as follows:

"In no other branch of the public service can a man's earnings be withheld from him beyond the periodical pay-day, and no private establishment could be operated for a single day if an attempt were made to introduce the custom prevailing in the navy, whereby a man is practically restricted to such amounts of money as

his commanding officer may choose to allow him. If enlisted men of the army, and of the marine corps when on shore, are permitted to draw the entire amount due them at the end of each month, why should enlisted men of the navy be denied the same privilege? In the latter case, a man might be justly compelled by law to retain on the books an amount sufficient to cover the cost of any clothing that he would be likely to require, as he has no yearly allowance for that purpose, as has his military congener.

"It is not that the generality of commanding officers are disposed to exercise their authority in a despotic or unreasonable manner, but that the denial of a man's absolute right to his legal earnings is offensive to his manhood.

"I have known a chief petty officer, with several hundred dollars on the books, to be accused of lying and attempting to obtain money under false pretenses, because he asked to be allowed to draw twenty-five dollars to send to his wife. In that instance his request was granted, but only on condition that the amount asked for should be paid in the form of a check, endorsed to his wife's order and given to the executive officer to mail.

"Can any officer doubt that many self-respecting mechanics would be deterred from enlisting by the knowledge that they might be exposed to such humiliations? Does any officer believe that the average recruit enters the service with any doubt as to his right to draw his pay in the same manner as do other free-born Americans?

"If the department has the legal right to withhold the pay of enlisted men, has it not an equal right to withhold the pay of officers, and does any officer believe that he would accept such an order without vigorous protest and appeal? Certainly not.

"If we aim at naval efficiency, we must man our navy with vigorous, self-respecting young Americans, men who will cheerfully submit to the demands of the most rigid discipline but who will not submit to the denial of natural and legal rights which are perfectly consistent with such discipline.

"Are we blinded in this matter by custom? Is the subject not deserving of consideration?"

Reduction in monthly money is doubtless too important a means of discipline to be discarded lightly. It has stood so long among us unchallenged that many persons believe that, if discarded, its place should be filled by some enactment of law. The merchant

service maintains its measure of order, obedience, and good conduct by money fines, and bothers very little with confinement. Give the captain the legal right to impose on an enlisted man a fine limited, for one offense, to so many days pay, and the end now reached by the exercise of a power which is possibly not beyond question, will then be reached in a perfectly unimpeachable manner and can create no grievance or feeling of injustice. Surely the authority reposing in every police magistrate in the land may be freely delegated to the captain of a naval vessel.

IX.

It is hinted, sometimes rather broadly, that sufficient pains are not taken by recruiting officers to bar out applicants who, filthy, ragged and unkempt, stand as living proofs of their own weak or vicious nature and of their failure to succeed in a land where the highest wages are thrust upon the most indifferent workman. Such recruits, if not already across it, live on the border between the world of self-respecting industry and that of the hoboe. Is it rational to expect them, in the navy, to display qualities which they lacked in civil life or to respect an oath to serve faithfully, something they never did before in all their days? Is anything more likely than that they will run away whenever the yoke of cleanliness, subordination, and regular duties grows in the least irksome?

What about their effect on their shipmates? What percentage of their class in any recruiting party is necessary to disgust good, sober, and willing fellows and make the latter curse the time they were induced to enlist? The thought of four years association with a set of brutes foul in body, foul in mind, foul in speech might well become intolerable and lead to the determination to desert at the first convenient opportunity. If the hint I have referred to be based on fact, we should not be amazed when that fact appears as a determining cause of desertion among the good as well as the bad.

Is it worth while to take into our ships men of the description mentioned, of the type of the tramp? They stay with us as long as they please, leave us when they please, and when the unsympathetic outside world crowds them a bit, they surrender themselves, accept the modicum of punishment by which their offense is purged, and grow fat again.

In the meanwhile the damage is done. Their very presence has probably forced better men out of our ships. These do not come back. "Une fois, c'est bien assez."

In my correspondence on naval matters I find this remark by a colleague:

"I am convinced from my own observation as well as by the testimony of others, that of the men who actually do desert, those who return are usually the least desirable. Men of steady habits find no difficulty in obtaining remunerative employment, but the vagabond, his money gone, is irresistibly drawn to the meal pennant. If an avenue of retreat were left open, during a man's first enlistment, a better class of men might be induced to try the naval life; men who realizing their ignorance of service conditions are now loth to bind themselves for the full term of enlistment.

"If we can attract such men, we shall be spared the necessity of accepting the scum of our great cities, men whose presence on shipboard is a menace both to discipline and decency, men whose actions in both foreign and domestic ports bring reproach upon the navy. Under such conditions, decent men would regard the term "deserter" as it is now regarded in every service but our own, as one of reproach."

X.

In the way of punitive methods the department seems to be greatly embarrassed in its endeavors to do complete justice to the individual without, at the same time, bringing the naval service into disfavor. The reason may, possibly, have been guessed in these sentences from the communication to me of an officer whose experiences entitles his views to respectful consideration.

"The forfeiture of citizenship, as a penalty for desertion, as well as the frequency of the offense, has constrained the department, apparently, to surround the offenders with technical safeguards, which make it difficult, if not impossible, to convict them of a more serious breach of discipline than absence without leave. The crime of desertion is of so grave a nature, involving as it does not only dereliction of military duty but violation of a sacred compact, that the leniency shown by the department has a tendency to weaken the moral sense, and thus to lower the tone of the whole enlisted personnel.

"If after a reasonable trial an honorable exit were provided

for men who have found that they enlisted under a misapprehension as to the nature of their duties, environment, and privileges, the crime of desertion would be one of comparatively rare occurrence, and the department might then feel free to pursue and punish offenders with unrelenting vigor."

Speaking as a layman and without legal training, I am tempted to suggest that desertion is a crime complete in itself when the inculpating act is committed. If a man leaves his ship on, say, October 30, not intending to return, he is a deserter there and then. He may change his mind (many, especially of the tramp order, do) but because he voluntarily comes back to the fold on December first he is none the less guilty than his shipmate who remains absent. He may get a smaller sentence or a partial remission in consequence but the nature of the crime is unchanged.

I have heard of a man who deserted his ship just as war was being declared with Spain, who gave himself up two years later, and, instead of being shot, under the fourth Article of War, was punished for absence without leave.

One might very easily be led to wonder how much dread enlisted men can entertain for naval discipline if thus exerted and exhibited, or what obloquy attaches, in their minds, to an offense about which there cluster so many dire threats, fearful warnings, and so few real penalties.

XI.

It has been suggested to me that deprivation of liberty as a punishment for minor offenses and for moderate overstaying of leave is an active cause of discontent, and that a money fine instead would work a great improvement. I present this suggestion without comment.

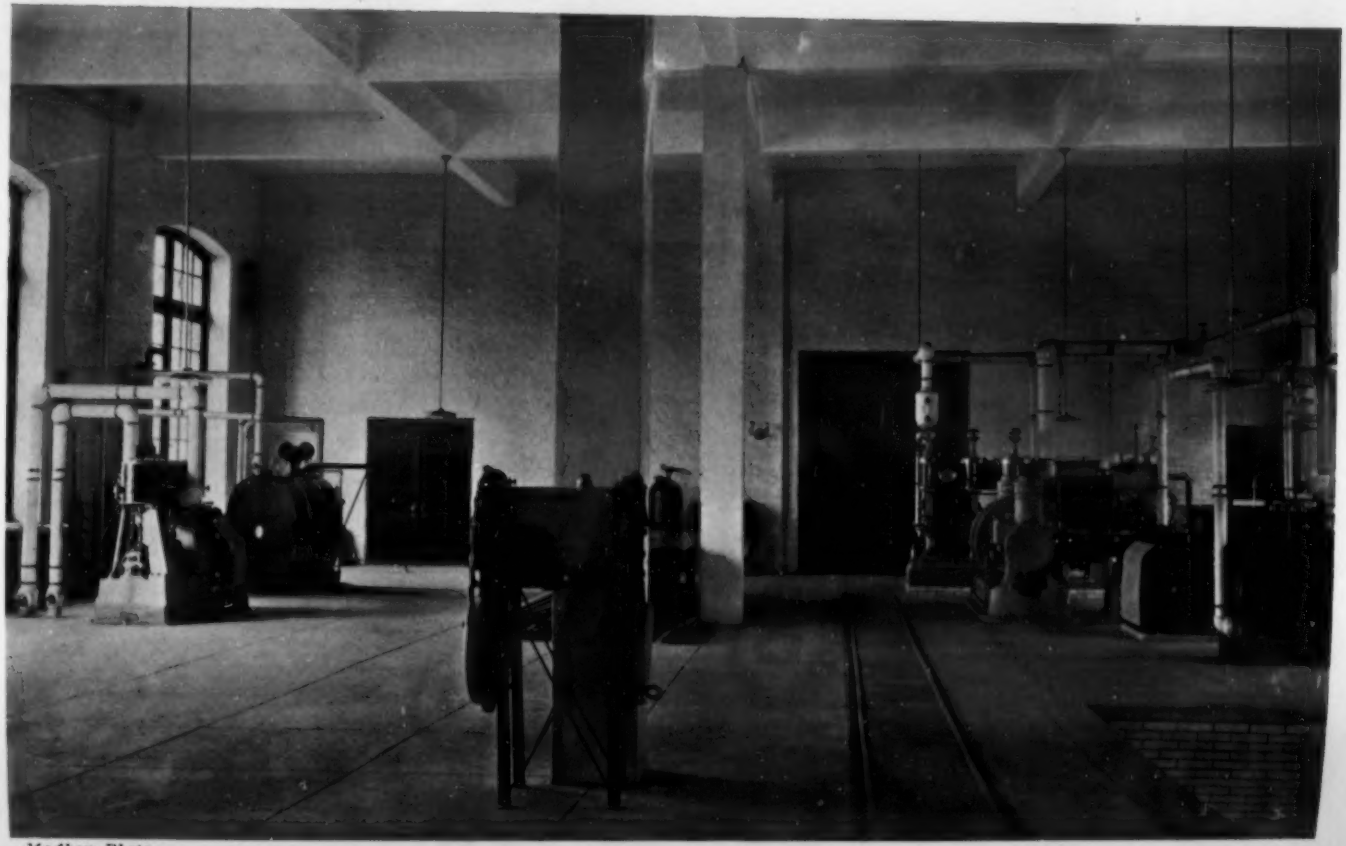
XII.

While carefully considering and faithfully presenting these views and theories of certain of my colleagues (and of many enlisted men as well) I am unable to come to any more definite conclusion than that fewer theories and more facts are urgently needed. A general and simultaneous investigation of the subject throughout the entire navy by painstaking and sympathetic interrogation among the blue jackets themselves would yield much light where now there prevails the darkness of haphazard con-

jection. The impulse to derive a general law from one isolated case is but too common. We seem, in dealing with this grave question, to cling to the *à priori* method of reasoning as a limpet clings to a rock. For us, of this twentieth century, Aristotle still rules the processes of the intellect and Bacon is yet unborn.

After the most exhaustive analysis of causes and after all causes susceptible of removal have been done away with, a certain percentage of desertion must still be looked for, due to special circumstances, special temptations, or special pressure. Thus, as not infrequently happens, a ship's company will buy a ticket to a remote point for an objectionable character, will escort him to the railway station and politely request him never to show his face on board the *Hackmatack* again; or every now and then we must "chercher la femme," or we must not be surprised by the flocking of foolish youth to El Dorado when a new Klondyke or a new Kimberly is discovered just abaft the beam. Until we have eliminated, as far as possible, every source of this distemper which is properly attributable to service conditions, the existence of desertion in the navy must be a reproach to us all, officers and men alike.

After that, any marked increase beyond the inevitable normal percentage of desertion, will indicate to the department that things are not quite right on board the *Hackmatack;* that discipline is slack or uneven; that the commissary steward is incompetent or indifferent; that the men are subjected to unnecessary nagging; or that the administration of justice is harsh and arbitrary, etc.; that, in short, it is high time to overhaul the captain and ask leading questions of the crew.



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GENERATING SET, DISTILLER AND EVAPORATOR

EXPERIMENTAL ENGINE AND ICE MACHINE

ENGINEERING LABORATORY

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

IS AMALGAMATION A FAILURE?

BEING AN EXAMINATION OF THE SO-CALLED PROOFS THAT SUCH IS THE CASE, AND A DEFENSE OF OUR PRESENT ENGINEERING ORGANIZATION OF THE COMMISSIONED PERSONNEL OF THE NAVY.

By LIEUTENANT-COMMANDER L. H. CHANDLER, U. S. Navy.

Throughout the last year, especially since the *Bennington* disaster, the newspapers and periodicals of the country, daily, weekly, monthly, maritime and non-maritime, professional and non-professional, in fact almost every regular publication that can be cited, have been filled with unfavorable criticism of the amalgamation feature of the Personnel Bill of March 3, 1899; the law that gave us our present organization. Much of this criticism, perhaps most of it, has been honest and of good intent, while some of it has undoubtedly been due to motives not of the best. It has ranged all the way from honest criticism by officers of the navy who have written disinterestedly and with the sole object of increasing the efficiency of the service, down to wild statements which can only have emanated from ignorance or malice, such as one reading as follows:

"The United States Government requires that a merchant ship of 3400 horsepower shall carry not less than three licensed engineers; while it may be assumed, from what we know of the matter, that *not a man connected with the engineering force on the Bennington would have been able to obtain a license.*" (The italics were printed in the paper as given here.)

Whatever the criticism has been, however, and from whatever source, apparently no one has heretofore felt it necessary to say a word in the defense, for the reason, I believe, that the friends of the present system have been so confident of its strength that they have looked upon these rabid attacks upon it as the surf which

breaks upon a rocky coast, sure to disintegrate upon the cold logic of facts, and have, therefore, believed no defense was necessary. Believing that the opposition should not be allowed an altogether clear field, however, I most gladly accept the invitation of the Naval Institute to present the other side of the case for the consideration of the officers of the service and of any others who may feel an interest in this, to us, most vital question.

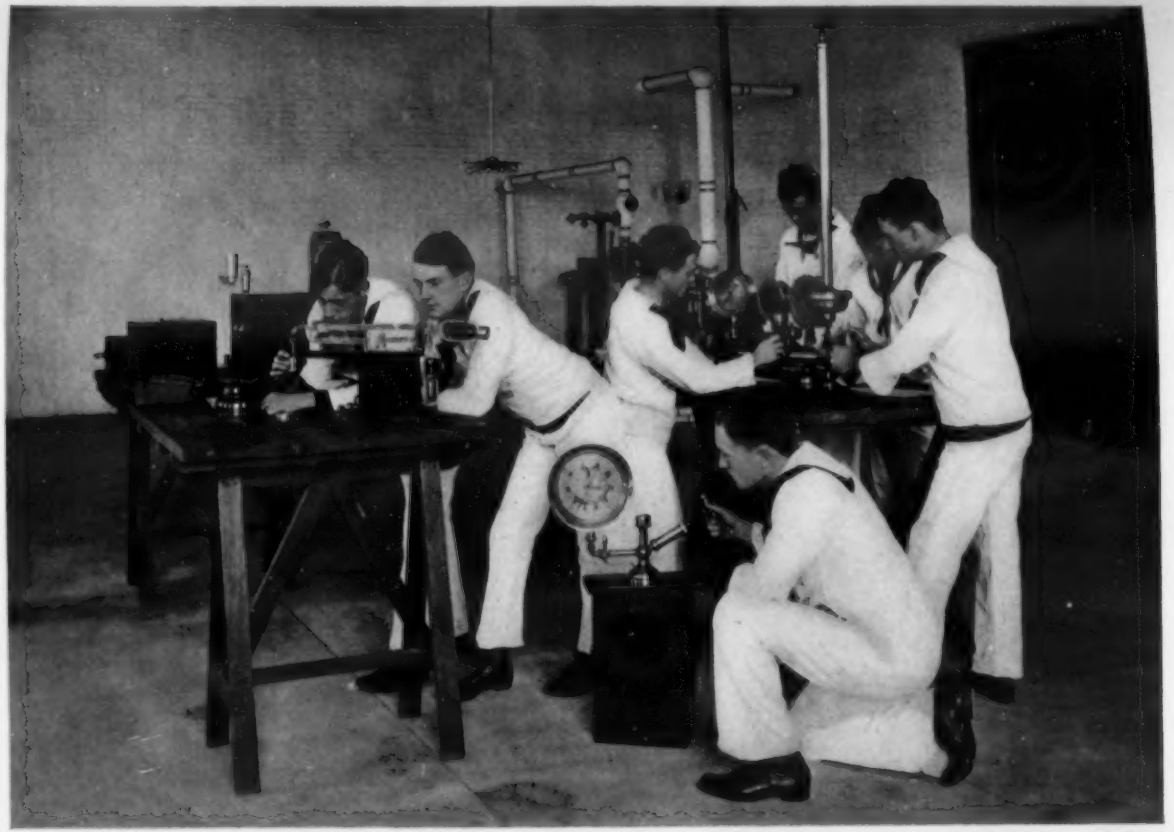
The attacks upon the amalgamated line have been so virulent and complete, embracing every feature of naval education, experience, and intelligence subsequent to entry into the Naval Academy (I am even surprised that some have not already demonstrated, to their own satisfaction at least, that the boys who enter the Academy are an unusually unintelligent lot) that I have felt it incumbent upon me, at the expense of being considered unduly prolix, to begin at the very bottom, and discuss fully the history of engineering education in the navy from the day when steam was first introduced, and to give full comparisons between the results of the training in our service, in the English service, by civil schools, and for the United States and English merchant services. I have tried to include in the main body of my paper simply the conclusions that I have drawn from the results of my investigations, but I have added, as appendices, full statements of the grounds on which my conclusions have been based. I most earnestly request my readers to scan these appendices for themselves and see whether or not my beliefs are well founded.

The general investigation on the results of which arguments are to be based seems to me to divide itself logically into two parts, as follows:

(a) What education in engineering do we give our officers prior to commissioning them, how well does this education fit them for assuming subordinate engineering duties aboard ship, and how do they compare, in point of technical education, with graduates of civil schools of technology and with licensed junior engineers of merchant ships?

(b) What do we do to develop our young officers in order to fit them for positions of engineering responsibility when they reach a rank which will put them in responsible charge of engineering plants?

The discussion in this paper will, therefore, take up the above subjects in the order given.



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CALIBRATING INDICATOR SPRINGS

TESTING STEAM GAUGES

ENGINEERING LABORATORY

As a preliminary step, it is necessary to carefully follow the history of undergraduate engineering education in our navy, which may be summarized as follows:

(a) With the creation of our navy, during the War of the Revolution, the practice grew up of commissioning officers from civil life or from before the mast, there being no other method of obtaining them. The steam engine not having been invented, the question of engineering officers did not enter.

(b) With the introduction into the navy of vessels propelled by steam, the first being the U. S. S. *Fulton*, in 1817, the need for engineer officers commenced to be felt, and, in 1842, the old engineer corps was created by Congress, appointments to it being made from civil life or from before the mast up to 1871.

(c) Feeling the need of higher education for officers of the navy, the Secretary of the Navy established the Naval Academy in 1845, but only line officers were trained there up to 1864.

(d) In 1864, however, realizing that a better education was as necessary for the engineer as for the line officer, Congress provided for special engineer classes at the Naval Academy, by creating two corps at that school, cadet midshipmen (to become line officers), and cadet engineers (to become engineer officers). The first regular class of cadet engineers was the one graduated in 1871.

(e) Up to this time the course of undergraduate instruction had been four years, but in 1873 (the class of 1877 was the first one affected) Congress made the undergraduate course six years, four of which were to be spent at the Academy as theretofore, while the last two were to be spent at sea on regular cruising ships of the navy. The reason for this change has been so often misquoted that attention is called to the report of the Secretary of the Navy of about that date, which states definitely that the real reason for the change was to reduce the number of yearly graduates, as the Academy was turning out officers faster than they were needed.

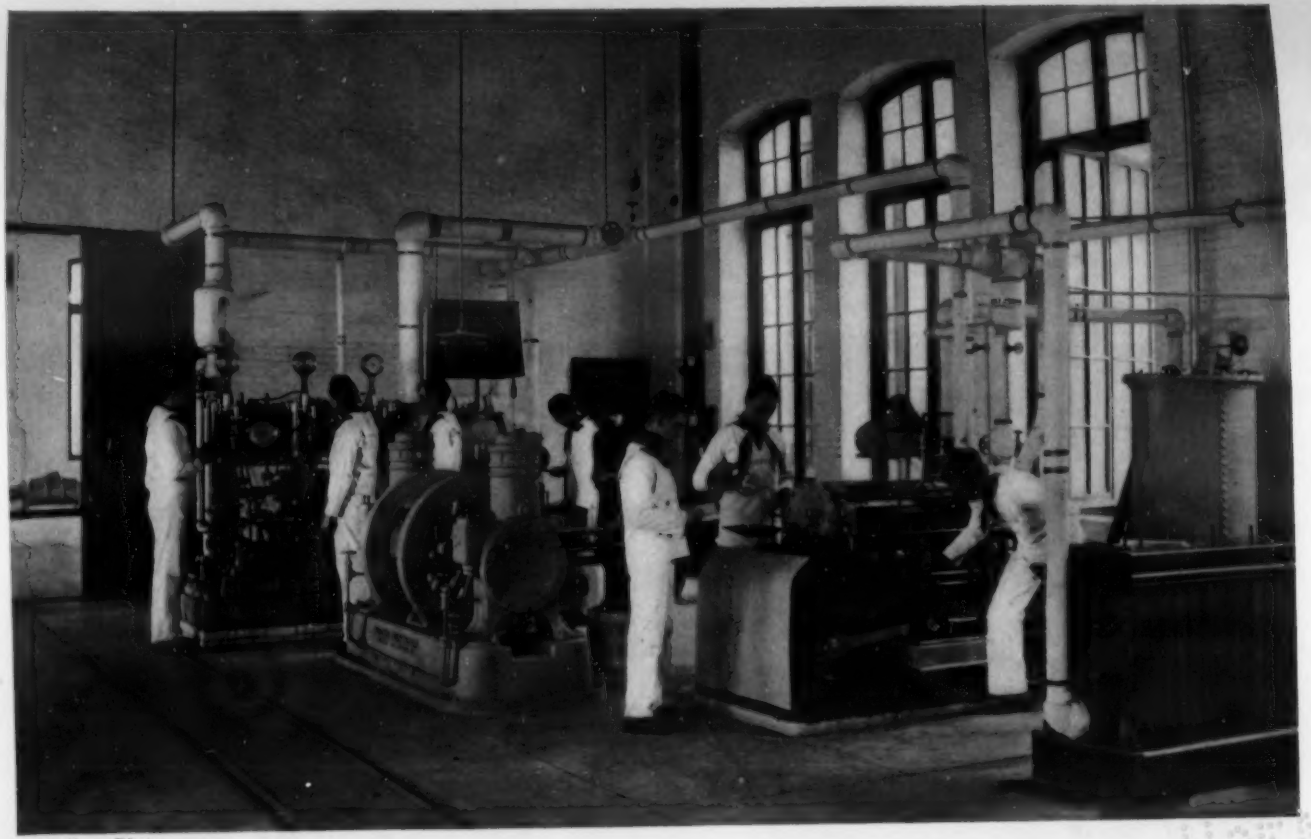
(f) The corps of cadet midshipmen and cadet engineers were continued side by side until 1882, when the two were amalgamated into "Naval Cadets." It is worthy of note, however, that the study of steam engineering was not confined to the cadet engineers alone, as will be seen by an inspection of the fairly stiff steam engineering examinations given in one of the appendices as having been set for cadet midshipmen.

(g) The last-mentioned system continued until 1889, when a law was passed providing that, at the end of the third year at the Naval Academy, each class should be divided into two sections. For the last year at the Academy and during the two years at sea prior to graduation, each section of the class pursued studies specially to fit itself for the special duties its members were to assume. The members of one section proceeded to fit themselves to be line officers and the others to be engineers. This does not mean, however, that prospective members of the line gave up all study of steam engineering, for quite the contrary was actually the case. Both sections of the class continued with much the same groundwork course, but each pursued certain special studies to especially prepare it for the end in view.

(h) This system, as described in the preceding sub-paragraph, continued in force until 1899, when the inevitable march of events caused a tremendous upheaval throughout the navy. Up to that time, from the introduction of steam machinery aboard ship in 1817, and the resulting creation of an engineer corps in 1842, there had always been two separate corps of officers employed, the line and the engineer corps. By that date, however, the clamor for something better had become so persistent among the more progressive officers of the navy (headed by the then Assistant Secretary of the Navy, the Hon. Theodore Roosevelt) that the old conservative element was routed, and the "personnel bill," under which we are now organized, became a law, amalgamating the line and engineer corps, and making all officers of the new line (subject to certain well-known and important, but temporary exceptions) subject to duty on deck or below as the exigencies of the service might demand.

Thus ends the statement in brief of our past organization for educating our officers in steam engineering. A careful reading of it shows one strong and continuous tendency, which I think must be apparent to every reader, and which received but a single check throughout the long series of years covered.

Let us bear in mind to start with the first case of amalgamation on record, the much-quoted case of the mixed soldier and sailor (or galley slave) crews of the days still further back. How quickly, among all really sea-faring peoples, the sailor claimed his right to handle the ship and fight her too; how quickly the soldier disappeared from the rôle of over lord and sole maritime



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warrior; and what a punishment was meted out to the caste-bound nations whose prejudices blinded them to the true logic of events! With this thought in mind, read the history of engineering organization and education in our navy and see how like it is; see how the opponents of amalgamation fail, as did the sea soldiers of old, to recognize the true and unvarying line of progress. From before the days of steam, we had officers commissioned from civil life or from before the mast, too often, if history speaks truly, by political influence rather than for skill, experience, and knowledge. The cry arose for officers of more knowledge, of better education, of higher attainments, men who would more thoroughly understand from both theoretical and practical points of view everything in connection with both handling and fighting a ship. The Executive created a school to meet this demand, which school was later recognized by the legislative branch as well.

Steam was introduced, and, with a lack of appreciation of the situation which was doubtless excusable, a separate corps of men was created to handle this new and mysterious agent. The soldier and the despised sailor again! Was the steam engine any more mysterious to the line officers of that date than were the many complicated fighting devices of the old soldiers to the non-combatant personnel that manned the galleys of the days even then long ago?

This false step once made, follow the ever-increasing efforts to correct it. Still came the same cry; give us officers better educated in *every* branch that finds room aboard ship. And so, with the first false step already taken, that of creating an engineer corps, both graduated and undergraduate, the pressure could not be withstood, and instruction was given to the cadet midshipmen in steam engineering.

Again the same old cry for officers educated in all branches, and, blindly and without recognition of the true principles involved, but yielding to an overwhelming pressure of which the true nature was not understood, cadet engineers and cadet midshipmen became one body. The separate commissioned engineer corps still remained, however. Its hour of fate had not yet come.

So far there had been no ebbing of the advancing tide. Ultra-conservatism, not even recognizing that it was attacked, awoke not in its own defense. But now, aroused by the encroachments

on its sacred tenets, that element awoke to life, and succeeded for a moment in stemming the tide of progress. Realizing that a better engineering education was necessary, the conservatives, clinging to "starboard" and "port" as the limit of a line officer's knowledge, succeeded in clouding the issue and in making it seem that only the cadets who were to become engineer officers needed a higher engineering knowledge, whereas, in fact, *it was every cadet who needed it.* The true principles of the development which we were undergoing (in part unconsciously) were not appreciated, a mistake was made, the tide ebbed a little, and the separation of each class of cadets into engineers and line officers at the end of the third year was made. This much remained, however, that the line cadets still studied steam engineering.

This temporary set back to progress met its inevitable fate, however, and the rebound, when it came, as it soon did, was all the greater for having been held back for a short period. The rebound broke down all the conservative barriers, and in the flood that followed the engineer corps ceased to exist.

Many reasons are now being advanced as having given impetus to the movement which resulted in the passage of the personnel bill, prominent among them being the need for a general increase of numbers due to the Spanish War; the past bickerings between line and engineer corps and its resulting loss of efficiency; the uneasiness of the engineer officers while occupying a so-called non-combatant position; the restlessness of commanding officers who felt themselves too much in the hands of the chief engineers, who, enwrapped in a mystery of superior engineering knowledge, too often absolutely dictated the essential movements of the ships through a lack of the special knowledge on the part of commanding officers necessary to properly control them; the service necessity for relieving the stagnation in promotion; the natural desire on the part of all officers for more rapid promotion and more pay, etc. Each and every one of these reasons, and probably many others, undoubtedly added to the impetus of the movement and removed opposition to it, but to my mind there was one great motive which was working (perhaps without their definite comprehension however) in the minds of those who sent this movement forward to success, and to this great reason, but for the existence of which the bill could never have passed, I seldom see reference made in the various discussions of the subject now on

McAboy, Photo.

MODEL ROOM—EAST WING

the carpet. To my mind this great cause of the reform of 1899 was the ever-increasing realization of the fact that the major part of the duties of the line and of the engineer corps were purely mechanical and that equal engineering knowledge was required of both corps as to all sorts of machinery; steam, air, electric, etc. In other words people saw that the naval officer of the day must of necessity be a competent engineer. This to my mind was the cause of the passage of the "personnel bill," and not a combination of many smaller and less important causes, many of them selfish in the motives inducing them. Such lesser causes undoubtedly aided in removing opposition, but history does not show that great upheavals and reforms spring from such roots.

In every great reform movement a careful search will reveal many mixed motives as having aided progress. Selfish motives doubtless enter largely, as do minor reasons, but these act mainly to remove opposition rather than to add impetus to the movement. They alone never sent any great and radical reform on to success. To accomplish that there has always been present some great and sound principle, often not directly recognized at the time, but nevertheless plainly apparent to the later student, working in the hearts and minds of men to urge them forward persistently and relentlessly in the right path.

This great motive in our case has been the insistent cry for all-around officers who knew their ships in every detail, who could work the sails and the carronades, who can handle turrets and engines of all kinds, steam engines, pneumatic engines, hydraulic engines, electric engines. Follow naval history from the beginning and you will see that from the days when sea warfare first became a science, "amalgamation" has been the key to success. The Spaniard refused to accept the first great amalgamation of sailing-ship days, and has refused to accept this later form as he did the older,—where is the dominion of Spain to-day? England first of all nations recognized the necessity for that first amalgamation, and her dominion forthwith extended to the ends of the earth.

We, to-day, have blazed the way towards the ideal condition. England has followed haltingly in our footsteps, having to-day the educational organization for engineering that we maintained from 1882 until 1889 and which was at last, after a temporary setback lasting ten years, thrown down by the great reform of 1899.

She will surely follow further,* and behind her will come lagging the other nations in which the blindness of caste rules that a man cannot be a military officer and a mechanic at the same time. Irresistible is the logic of facts, and although the ultra-conservatives wail and predict evil, find petty explanations of things accomplished, and predict dire misfortunes for the future, the great ruling principle is there nevertheless and it will not be denied. Periods of no progress or of negative progress there will doubtless be, but we are bound to advance in the long run, and in the end the educated, sea-going mechanic will rule our ships. The rising waters stayed not at the mandate of Canute, nor will the dire prophesies and melancholy lamentations of our naval "anti-imperialists" (to paraphrase a term) prevent us from seeing our ships officered in the end by that most perfect type, the sea-going, all-around engineer.

From the above historical summary and the conclusions drawn therefrom let us pass to an examination of our methods of naval engineering education as compared with similar instruction as given by others.

The conclusion that I draw from a careful examination of the information displayed in the appendices to this paper is that from no engineering school in the world does any young man go forth better equipped to become a proficient engineer, either theoretically or practically, than from the Naval Academy of to-day. And I believe it is apparent that, even in the days of the cadet engineers, the special course of engineering instruction given them was distinctly inferior from a practical point of view to that now given to the entire corps of midshipmen. I also conclude that the Naval Academy graduate of to-day is in possession of ample knowledge to enable him to pass the required examination for license as a chief engineer of an ocean-going steamer of unlimited tonnage.

The most difficult comparison to make is of course that between our graduates and the licensed men of the merchant marine. It may be said in regard to the two classes that, as a rule, our men receive more theoretical and less practical knowledge than the men who have worked up through the engine-room of a merchant vessel to a chief's license. These latter have to get their theoretical knowledge of their own volition and with but little assistance, outside of probably over-long working hours, while we give

* Since this was written she has.—EDITOR.

McAboy, Photo.

WOOD-WORKING SHOP—BENCH WORK

up some hours of practical work in a man's younger days in order to beat into him a good theoretical knowledge of the subject in the first place. And it is to be noted that in the six years' probation of an Academy graduate he gets a large share of practical experience, even when compared to the three years' service required of a candidate for a merchant license. If a solid understanding of the theoretical groundwork of a profession be considered necessary to produce a first-class man in other mechanical professions, as I believe is universally admitted to be the case, I cannot see why the same is not true in marine engineering. Adopting this principle as true, I advance the claim that the average graduate of the Naval Academy to-day is far better fitted to be a chief engineer's assistant than is the average man who secures an assistant engineer's license in the merchant service.

I ask my reader to carefully consider the appendices here presented, and to decide for himself whether or not my views, as expressed above, are based upon sound reasoning.

Passing from the engineering attainments that must be possessed by a graduate of the Naval Academy of to-day, which I have claimed to be very high, we come to the next phase of my treatise and must seek our answer to my second question, which I have expressed as follows:

"What do we do to develop our young officers in order to fit them for positions of engineering responsibility when they reach a rank which will put them in charge of engineering plants?"

As a preliminary to an effort to answer this question we must consider what the personnel bill, in its letter as far as it was possible to express it, and most thoroughly in its spirit, called upon us to do. In so doing we must omit from the consideration of the question the several different classes of officers now temporarily existing in the navy for special purposes as a result of the present law, and consider the midshipman who has entered the Academy under this law, received the combined course resulting from it, and been graduated at the end of four years with the degree of knowledge of engineering already described.

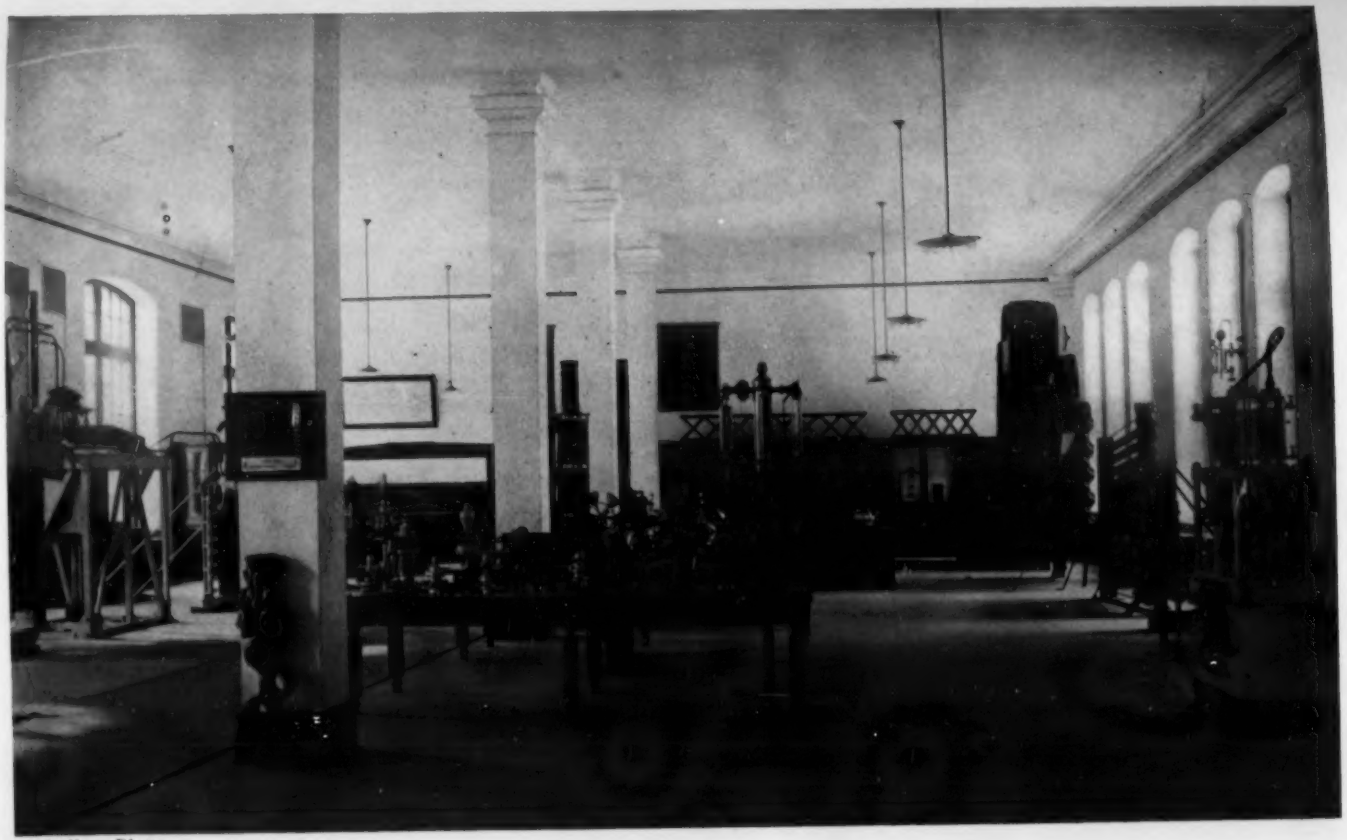
The provisions of the personnel bill, and its spirit, if they mean anything, mean that this young man should be given, both while on his two years' undergraduate cruise and while in junior ranks, instruction and junior duty, under competent superiors, in the following general branches:

(a) Deck duty, including ship handling.
(b) General divisional work.
(c) Powder and torpedo divisional work.
(d) Navigation work.
(e) Ordnance work.
(f) Electrical work.
(g) Steam engineering work.

As these young men gained in experience and practical knowledge, and acquired confidence in themselves and habits of command, it was most certainly intended that the supervision over them should be gradually withdrawn and that their duty should become more and more responsible as they reached higher rank, until they became competent to assume full responsibility in every branch.

It was most certainly never contemplated that a young ensign or midshipman should be placed in a position of full responsibility in any one branch, as was the case with the chief engineer of the *Bennington*. In the palmy days of engineering education, when there were cadet engineers at the Naval Academy, the proposition to put an assistant engineer in the position of chief aboard a cruising ship would have been received with horror. A young engineer officer performed subordinate duties for a ridiculously long time before he was trusted in sole charge of a machinery plant. Now, however, the pendulum has swung to the other extreme, as shown in the *Bennington* case, and young officers of good engineering education but of little experience are given the most responsible positions. The commanding officer of a ship can watch most carefully his executive officer and his navigator, and does so watch them from day to day, but the duties of his chief engineer are performed below deck, where it is most difficult to watch him, and his onerous duties are left to him with a freedom from supervision unknown to any other officer in the ship. Yet, as a rule, where there is a shortage of experienced officers, it is not into the chief engineer's position that one of those available goes.

So also in regard to the branches enumerated above as those in which the present organization demands that a young officer shall be given tutelage. But a few years ago his entire attention was given to routine duties of deck and gun division, and even in those the more important things had too little stress laid upon them. He was made to pay little attention to ordnance or electri-



McAboy, Photo.

MODEL ROOM—WEST WING

cal work, and his navigation was too often merely perfunctory. His steam engineering, except for those who were confined solely to that by law at different periods, was noted for being entirely neglected, except in cases where the young man himself made exceptional efforts to learn.

The awakening of the new navy came with the introduction of real target practice, but unfortunately that awakening has as yet been for the duties above decks only. It has brought ordnance to the front, and so much electricity as is involved in the handling of turrets. Beyond that it has not gone to any appreciable degree.

In other words, starting out with a period in which little encouragement or opportunity was given to a young man aboard ship to become familiar with the really important work of his profession, certain well-known causes have of late years come into operation to ensure that he shall spend time and earnest effort in acquiring knowledge and skill in certain branches.

Up to the time of the *Bennington* disaster, however, the spirit to inspire a movement towards steam engineering was almost entirely lacking, and for many well-known reasons, including prominently among them the enormous deficiency in the total number of officers available to do the work at hand, the time and attention given to steam engineering was sadly below that given to the other branches.

The only further statement that I care to make in regard to the situation is to quote, without comment, from the last official annual report of the Chief of the Bureau of Steam Engineering the following paragraphs:

"Owing to the absence of specific instructions to that effect in the personnel bill, combined with powerful adverse influences within the department, for three years absolutely nothing was done by the younger line officers in acquiring engineering experience, and later, owing to the large number of ships kept in commission, and the scarcity of officers, but little in that direction was accomplished.

" . . . Credit must not be withheld also from a few officers of the line who by their own personal exertions perfected themselves in engineering, and served, or are serving, with marked efficiency in most responsible engineering positions afloat.

"So few officers of the line are taking up engineering seriously that the situation is becoming alarming.

"That the department must do something to relieve this situation, and do that something at once, is only too obvious to the most casual observer of present conditions. . . . That line officers can become good engineers has already been proved, but that they must have experience to become so, and that experience must be acquired in subordinate positions. No young officer out of the Academy but a short time, who would not be given charge of the deck except under the supervision of a senior officer, should be placed in charge of the engineer department of any ship, as has been done.

"Engineering logically belongs to the line, and the line should be made to perform that duty earnestly.

"All the younger officers of the line must be given engineering duty, and must be made to realize the importance of their responsibility. This duty must be at first in a subordinate capacity, and no officer should be given charge until his record shows his fitness for such duty. The examining board must be strict in its examination for promotion, and before the board engineering must rank with seamanship, gunnery, and navigation."

Considering the far less degree of supervision which it is possible for a commanding officer to exercise over the work of his chief engineer than over that of any of his other officers, would not one sentence quoted above be more accurate did it read: "No officer should be placed in charge of the engineering department of any ship until he has attained in that branch a length of service, a degree of experience, and a record for ability at least equal to what is demanded by the department in other branches before an officer is willingly ordered as the ordnance officer, navigator, or executive of a ship of like importance?"

To sum up, I believe it may be safely said that, so far as engineering is concerned, the letter and spirit of the personnel bill have, for various well-known reasons, prominent among which has been the scarcity of officers, not been complied with in the following particulars:

(a) Young officers have not, in general, been given subordinate engineering duty.

(b) Young officers of but little experience of any kind have been given more highly responsible duties in engineering than they have in other branches.

(c) Young officers have not been encouraged to give special

McAboy, Photo.

WOOD-WORKING SHOP—LATHE WORK

attention to engineering, and such as have done so have done it without any special assistance or smoothing of their path.

These statements are merely an epitome of the remarks of the engineer-in-chief as quoted above. If, as he states, the law as provided in the personnel bill has not been carried out, it inevitably follows that we have no experience at hand on which to base a criticism of the results of the bill, for it has not been proved a failure if its provisions have never been put in force. The first remedy for the present condition will, therefore, be, it would appear, to carry out the provisions of that bill. The fact that, under decidedly disadvantageous circumstances, a few line officers have "by their own personal exertions perfected themselves in engineering," and have served, or are now serving, "with marked efficiency in most responsible engineering positions afloat," as stated in the paragraphs quoted above, is an earnest that, with proper encouragement and assistance given them, we would not long be in want of competent sea-going engineer officers.

To this extent the personnel bill, if carried out as it was intended to be, would accomplish everything that is claimed for it; of that I am satisfied. It would, as soon as the grades are filled to their proper limits, give us an ample number of officers competent to perform the ordinary duties afloat and ashore of driving engines, caring for them, and of inspecting their construction and installation.

To these limits I am convinced that the present organization is most admirable, if carried out in its entirety. There is a phase beyond this, however, in regard to which I, as a most consistent and ardent advocate of amalgamation, believe a change should be made. This, however, is not in relation to steam engineering alone, but relates to ordnance and electrical engineering as well. This phase is the question of providing, not operating engineers of the several branches mentioned, but *designers.*

That constant sea-going does not permit a man to fully develop his latent abilities as a designing mechanical engineer of any branch is shown to be acknowledged in foreign navies by the fact that most of their designers are non-sea-going civilian employes. This foreign practice I believe to be as far from the happy mean in one direction as ours is in the other, for it is hard not to believe that it is not only advisable, but absolutely necessary, for the designer to have some practical experience afloat with the gear which he is called upon to design.

Admitting this, it is evident then that, at some point in the career of an officer, it must be decided whether or not it is best to permit or to demand that he shall specialize as a designing engineer in one of the branches. Having had sufficient experience afloat and ashore to develop his particular tastes and abilities, such selection should thereafter be made as soon as possible.

And here we must consider for a moment the present English system of subdivision of students into line or engineer officers, although in their case the designing features does not enter to any great degree. Their system now is, as already stated, on the same principle as was ours from 1882 to 1889, and under it all undergraduates are given the same course of instruction. At the end of this period the division into engineers or line officers is made, and in so dividing the inclinations of the young men themselves are supposed to be consulted as much as practicable.

From the point of view of the inclination of the boy himself, we see that a young man of immature years, who knows nothing of the world in which he is to pass his life, is called upon to express a preference by which he must abide throughout his whole career. Manifestly he has a responsibility thrown on him in the matter which he is not fitted to bear, and he decides for temporary and oftentimes foolish reasons, and but too often in direct opposition to his best interests and to those of the service.

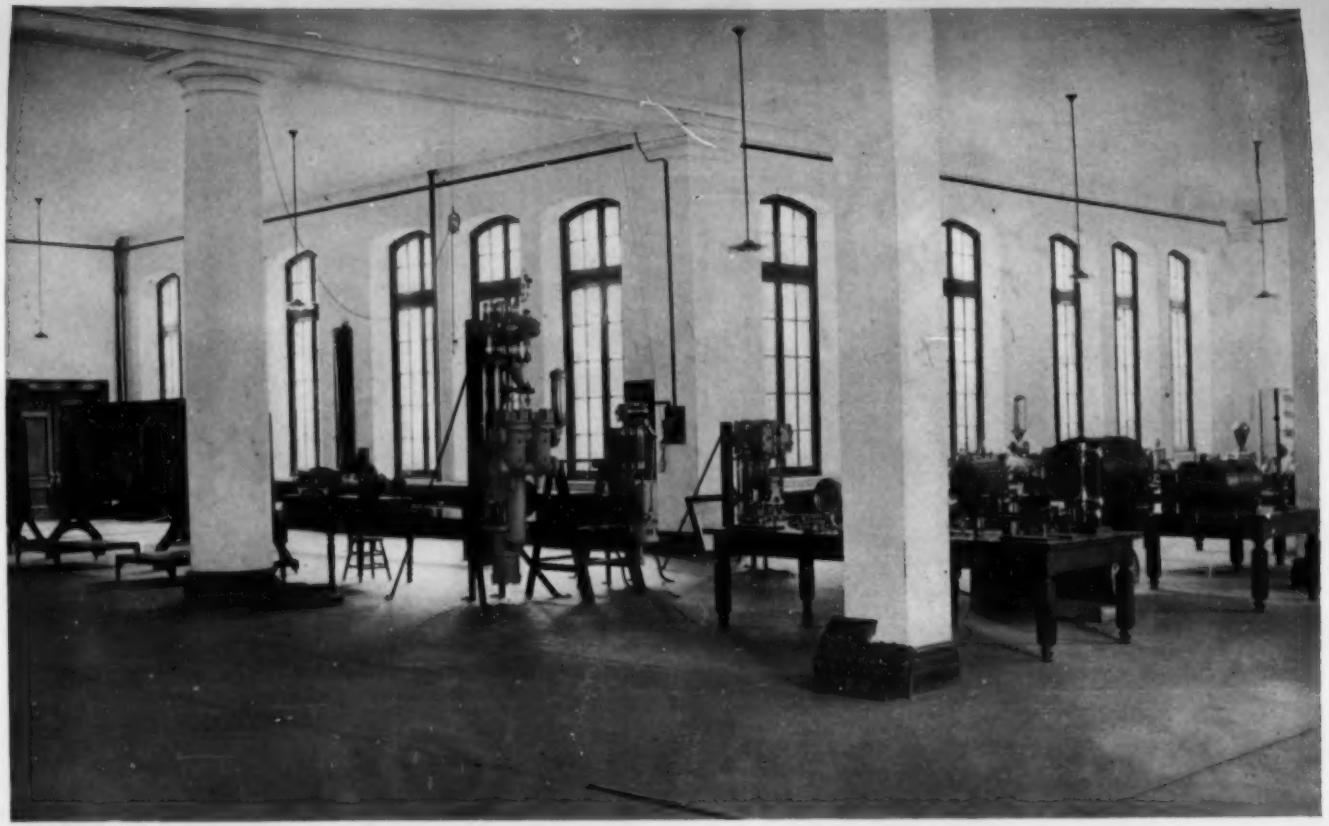
From the point of view of the service, it may be said that the authorities are called upon to select some engineers from among a large number of very young men who have no records to refer to beyond some academic marks, whose habits of life are not formed, and who, with a few noted (or notorious) exceptions, form a colorless and undeveloped mass of raw material.

Manifestly, neither the young men themselves nor the naval authorities can form any sound judgment in the matter from the facts then at hand.

While the conditions outlined above have no bearing on the selection of engineering designers for the English Navy, they do have a most direct relation to the various schemes proposed to find such for us.

A full consideration of all the phases of the question leads logically to the following order of procedure:

(a) All undergraduates should be given the same education, and that should include a most thorough course of general me-



McAboy, Photo.

MODEL ROOM—EAST SIDE OF CENTRAL WING

chanical engineering, with a superstructure of steam, electric, and ordnance engineering. This should be at the Naval Academy.

(b) During the two-years' cruise, if that is to be retained, the duty of the young men should be so arranged and shifted that each and every one of them will get proper instruction and experience in all branches. The older officers should be forced to attend to the duty, now far too often neglected by them, of instructing, aiding, and directing these young men in the pursuit of their studies.

(c) After commissioning, as ensigns, lieutenants junior grade, and lieutenants, they should be called upon to perform all the duties of all grades, according to some regular system, with gradually increasing degrees of responsibility and decreasing degrees of supervision, until, upon coming up for examination for promotion to the grade of lieutenant-commander, they should all be fit to perform the ordinary daily duties in any branch without supervision and with full responsibility attached. In other words the provisions of the personnel bill should be carried out and not disregarded.

(d) The examining board should see that no officer becomes a lieutenant-commander who does not fulfil the requirements of the preceding paragraph.

(e) Each year, from the lieutenant-commanders commissioned as such therein, there should be a certain limited number selected to become engineering designers, some steam, some electrical, and some ordnance. It is not necessary for me to deal with actual numbers, except to state that they would be comparatively few in number each year, especially after a reasonable number had been secured. The personal preferences of officers should be considered in the selection as far as possible.

(f) Officers specially selected for any engineering branch upon commissioning as lieutenant-commanders, should have their duties while holding that rank limited to the special branches for which they are selected, and at least three years of their service in that grade should be at sea engaged in work in one of the special branches. Shore duty in the grade should also be confined to the special branch for which selected.

(g) When an officer who has been selected for a special branch comes up for examination for promotion to the grade of commander, his examination, while including all general subjects, should be especially complete in regard to his special branch.

(h) After receiving his commission as a commander, each such officer should from that time on be employed under the bureau concerned, and on shore duty only, except that this last phrase should not be so construed as to prevent such an officer from being sent aboard ship temporarily and for a limited time, not in a responsible position, but as an observer.

(i) All such officers, upon obtaining their commissions as commanders, being no longer a part of the available sea-going force, should be made extra numbers in the grades, each one to thereafter be regularly promoted at the same time as the man of the regular line who stood next above him on the list.

(j) In addition to the fact that the entire service of such a specially selected officer in the grade of lieutenant-commander would constitute such a course, some previous opportunity should be given to officers who develop special tendencies to take a high post-graduate course in such branch as they may select. Something has been done in this direction already in the creation of two special post-graduate classes in ordnance and steam engineering, but the young men who take these courses are selected upon commissioning as ensigns, which I believe is, as a rule, too soon, for the reasons previously given in the discussion of the present English system of selecting engineers and of our system for doing the same thing between the years 1882 and 1889. An ensign, just commissioned, sees a chance, by taking this course, of getting a year and a half of shore duty in pleasant places, while his less fortunate classmates (or so they appear to him) are still at sea, and this prospect is doubtless sometimes the main motive which leads him to elect for the course, especially if he happens to contemplate matrimony at about that time.

(k) It is also believed that this method of selection for the course is too limited as to the time when it takes place. Many young men at the time when they commission as ensigns have not found their bearings definitely enough to permit either the department or the men themselves to properly judge in the matter. Even in the short time during which the ordnance class has been running I have heard many officers of undoubted qualifications bitterly repine that they were of too high rank to be permitted to take advantage of the course. And the system as it stands is incomplete, in that it does not include a course in electricity and wireless telegraphy. So I believe that this system of post-gradu-

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EXPERIMENTAL WORK—MEASURING PITCH OF SCREW PROPELLOR

ate education should be made available for any ensign, lieutenant junior grade, or lieutenant, as the department might select and the exigencies of the service permit.

(l) Officers of the three lower grades while on shore duty should be sent to duties similar to those that they now perform, but should be specially supervised by officers of the grade of lieutenant-commander or above who have been selected for the special branches.

(m) This would involve providing a sufficient number of special branch officers of the grade of lieutenant-commander or above (carried as extra numbers in their respective grades) to detail one in each branch as the head of the corresponding department at each navy yard of importance, and one in each branch as supervising inspector at each important private works or group of such works conveniently arranged (Cramps', the New York Shipbuilding Company, and the works of Neafie & Levy, would form such a group) and for design and other work in the several bureaus. These officers would have under them younger ones not yet specially selected, but each developing his own particular tastes, learning, and at the same time doing valuable work for the government, all under the supervision and instruction of an older man specially qualified for the purpose. And here it must be repeated, that such older officer must be made to realize that it is as much a part of his work as anything else to *instruct and encourage* his juniors while employed in this high class of work under him.

(n) The motives of all officers desiring to take up a special branch should be most carefully scanned, and only those should be allowed to do so of whom it may be confidently felt that they are seeking the work for the work's sake and not for any extraneous reasons. The special detail must be made attractive to officers who are willing to work, and this will be done by carrying them for shore duty only after they reach command rank. Having been made attractive in this way, however, the utmost care must be exercised to ensure that only officers are selected who are attracted mainly by the character of the work and only secondarily by the incidental rewards. This I know may be hard to accomplish, but to assist in doing it it should be made a rule that any show of lack of zeal or special aptitude in his particular branch that develops in any officer up to the time when he obtains

his commander's commission would result in disbarring him from the selection which he seeks. After becoming commanders, any slackening up in work should result in the detail of such an officer to the most undesirable and least important stations available, should his failures fall short of those necessary to enable the examining board or a court-martial to rid the service of his presence.

(o) Although not germane to the present discussion, I may add here that some generally similar course of instruction in regard to the handling and training of personnel might well be added, although, as there is no qestion of higher education for designing purposes involved, it would not be necessary to separate such officers from the regular line as proposed for designing engineers.

Such a system as that sketched above would provide a large number of highly educated practical engineers in all branches, thoroughly capable of performing all work of inspecting and driving machinery of all kinds, and in addition would furnish a comparatively small number of specialists who are practical men of experience afloat, and not merely theorists, to do designing work and to supervise and instruct the younger officers. In other words instead of trusting to the unaided efforts of individual officers to educate themselves in special branches, often in the face of the greatest discouragement, it would then become the practical policy of the department to aid, encourage, and reward those that are so disposed.

That the lack of engineer officers of to-day is due to the great increase in the size of the navy and not to the passage of the personnel bill is proved by Appendix J; that the material from which to choose is far greater in quantity than ever before is shown by Appendix K; and that the nature of that material is as good or better than it ever was before, and as good or better than any other in the world, is shown by the other appendices. Therefore, if there is any failure in our present system so far as other duty than designing is concerned, it must be to a lack of wise administration subsequent to graduation, enhanced by the difficulties resulting from our great shortage of officers, that the trouble is due, and not to the wise provisions of the personnel bill.

The system recommended by me in this paper, although very similar in its general lines to the one recommended by the engineer-in-chief in his last annual report, was practically developed

MODEL ROOM—WEST SIDE OF CENTRAL WING

in my mind before I saw that report, and even now I cannot improve much on the words that I used several years ago in a discussion of an essay on "Naval Administration and Organization," by Lieut-Comdr. John Hood, U. S. Navy, which was published in the Proceedings of the Naval Institute, whole No. 97, of March, 1901, from which discussion I wish to quote as follows:

"The truth of the matter is that at the time of the passage of the personnel bill the navy had just been enormously enlarged, and it has remained so enlarged ever since. Had the personnel bill never been passed, we should to-day have exactly the same outcry for more engineer officers, and the need would be just as great (see Appendix J to this paper). The demand for more line officers is to-day just as great, if not greater, than that for more engineers, and it would be just as correct to charge the present shortage of line officers caused by the expansion of the navy to the workings of the personnel bill, . . . as it is to charge upon that measure the present strong need for engineer officers caused by the same enlargement. . . .

"In other words, I deny that the amalgamation has reduced the number of competent engineer officers available, and assert that the present cry for more engineers is caused exclusively by the same reasons that have brought about the present great scarcity of sea-going officers of both branches.

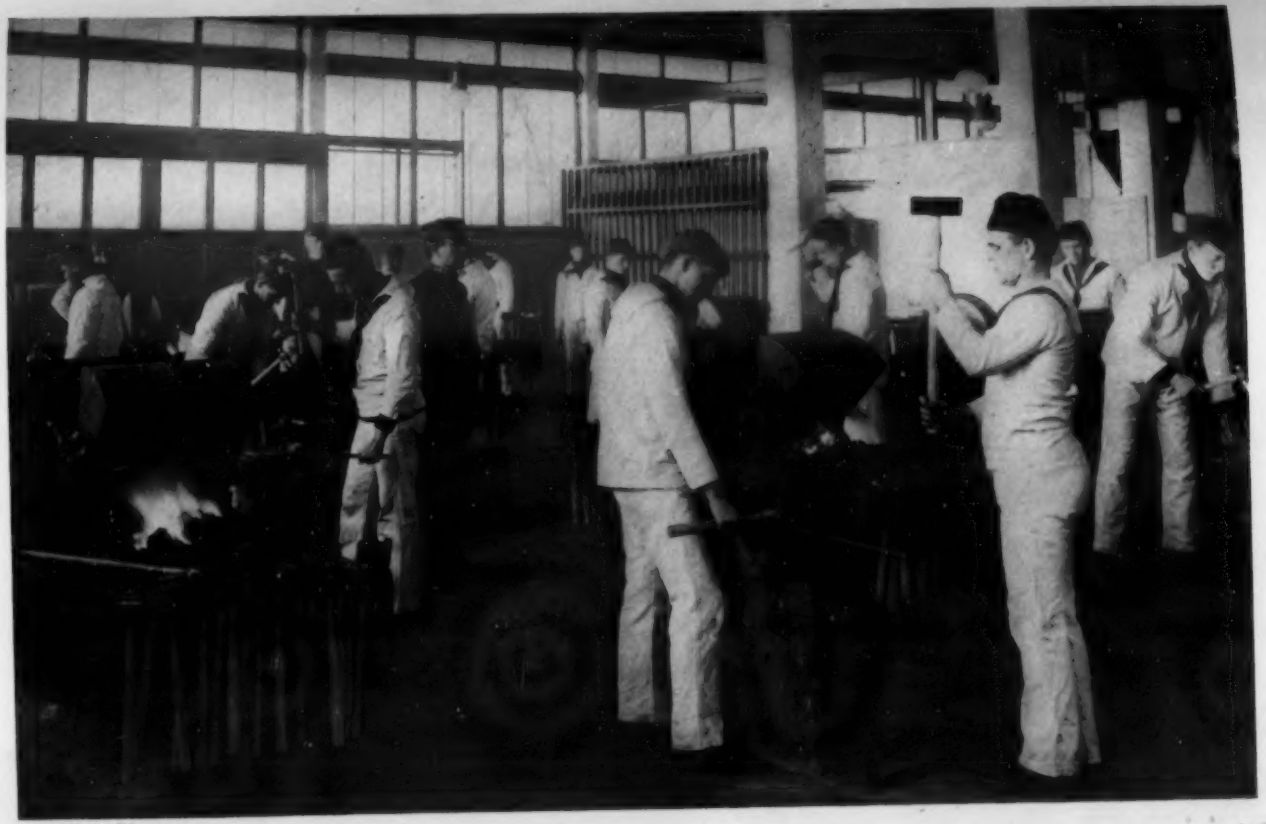
". . . The department has at its disposal to-day a certain number of line officers available, and in assigning them to duty a certain proportion go to each branch of the service. Because the actual number thereof assigned to engineering is not enough, the personnel bill is blamed, but in my opinion the Chief of the Bureau of Ordnance might as justly claim that, because he is short of inspectors and has to leave important work to civilian sub-inspectors, who have in many cases proved incompetent, therefore he ought to be given a separate corps of officers to do his work and his work only. I am confident that, could we get a sufficiently great total number of officers in the line of the navy so that each branch of work could have a proper number of units assigned to it, then the shifting of these units from one branch to the other according to their adaptability would become a comparatively easy matter, and we would find the now ever-increasing complaints against the amalgamation feature of the personnel bill dying away to nothing.

"I believe that this would be true even with the present officers, who have not been specially brought up to meet the conditions of to-day, were there only enough of them. I have confidence enough in the ability of my brother officers to believe that in that case, while each man could not become thoroughly expert in every branch, still, when an expert was needed in any particular subject, it would not be difficult to lay hands on him. It is hardly more difficult now to find an *expert* for a particular duty than it is to find *anyone, expert or not.* As well condemn the present system because every man in the line is not competent to do the design work for the Bureau of Ordnance as because everyone is not a competent designing engineer.

"Being possessed of the abiding faith set forth, that if the total were only large enough the subdivisions would arrange themselves, even when the total is made up of officers raised under the old system, I am still more confident that, by the time the officers of the navy are all men who have been educated for the present conditions, the new line as a whole would be most thoroughly and efficiently competent to perform all the duties, line and engineering. There would still be the occasional square peg in the round hole, of course, as will occur under any system, but with a large number of pegs and holes to manipulate, the necessity for putting the two misfits together would be less likely to occur than under the old system.

"I would have a line of sufficient total numbers, not, as to-day, with one thousand men to fill two thousand places. No system can make one man into two. This, of course, Congress must be induced to provide, and as long as it is not provided no system will produce good results. Then each line officer should be aided by the department as much as possible in developing his particular faculties in certain directions. . . . .

"Every officer who graduates from the Naval Academy can, as far as human nature renders it possible to make such a statement, learn to perform the daily duties of the turret, deck, and engine-room equally well, and can give satisfaction in the performance of them all. In so doing the younger officer will find himself naturally attracted in a particular direction, and a desire to be known as a qualified specialist will, in nine cases out of ten, lead him to become an expert in one or even more of the special branches without losing general efficiency thereby. The tenth



McAboy, Photo.

PRACTICAL WORK AT THE FORGE

man, who feels no special interest in anything, is the man who should be used to stimulate promotion by prompt action on the part of the examining board. There is no room for him in the navy.

"I believe in a line of the navy, each member of which shall be able to perform efficiently the daily duties of the ship in all branches, on deck and in the engine-room, and the care and handling of turrets, guns, machinery, and torpedoes, the caring for and running of dynamos and motors, and even, iconoclastic as it may seem, the handling of the accounts of the pay as well as of all other departments.

"Then let each man seek his bent in designing engineering, one or more branches, and with the system of warrant and petty officers now in existence I believe we would have the finest organization in the world.

"We now lack officers and we lack all classes of petty officers, and our present troubles spring far more from this than from the system. Get them, and I believe the system I have herein sketched out would give up everything that could be desired."

The passage of time and the events which it has brought about, together with much thought, experience and patient research, have confirmed me in my older belief as expressed in the paragraphs just quoted.

It is interesting to consider the clause of a bill (or rider on some other bill) that Congress would have to pass to so modify the present law that the system that I present in this paper could be put into full operation. Such a clause would read somewhat as follows:

"Provided that, on the first day of each July subsequent to the passage of this act the President of the United States shall designate from the number of line officers of the navy who have been promoted to the grade of lieutenant-commander during the preceding calendar year, such number of officers as is in his opinion necessary for the purpose to be thereafter set apart for duty solely in connection with steam engineering, electrical engineering, or ordnance engineering, such officers to be selected in accordance with their proved special fitness in the particular branches for which they are selected; provided further, that such officers so specially selected, shall, while they remain in the grade of lieutenant-commander, be available for either sea or shore duty,

but only in the special branch for which selected; provided further, that each such officer after promotion to the grade of commander, shall be available for shore duty only in his special branch, except that this provision shall not be so construed as to prevent the ordering of such officers to temporary service afloat for short periods for purposes of inspection and instruction only; provided further, that such officers so specially selected shall be promoted to the grade of commander in regular turn under the present law; provided further, that every officer so specially designated for shore duty only under this or any other law, shall, upon reaching the grade of commander, become and thereafter remain an extra number in whatever grade he may be, and shall thereafter be promoted from time to time in due course, at the same time with the officer on the regular line list at the time next above the position which the said specially designated officer formerly occupied on the said line list; provided further, that the pay and allowances of such special officers shall be the same as those of officers of the regular line of the navy; provided further, that the total number of such officers thus set apart for special duty in the grades of lieutenant-commander alone shall not exceed for steam engineering more than ———, for ordnance engineering more than ———, nor for electrical engineering more than ———; and provided further, that all such selection of officers for special duty and all subsequent promotions of such special officers shall be dependent upon their satisfactory completion of such special post-graduate courses and their passing of such special examinations in their particular specialties as the President of the United States may from time to time direct."

It is believed that this clause, when stripped of its necessary legal verbiage, is simple and direct; and that it accomplishes but one thing, the authorization of a certain limited number of extra officers specially fitted for the higher designing work required. It is further confidently believed that, as soon as the present increased size of the Naval Academy provides a large enough total number of officers to do the work at hand, the change of the law proposed above would do everything that is necessary or desirable. In considering the proposed clause I think all must be struck by its simplicity and by the slightness of the change which it contemplates. Such being the case, the mind must at once reach out for an answer to the question:

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IRON AND BRASS FOUNDRY—MOULDING IN SAND

"If this simple and slight change will do all that is necessary, why has it not been possible already, without change of law, to take most of the steps indicated as necessary for the betterment of our personnel?"

The answer to this question I will leave for my readers to find for themselves.

Since the passage of the personnel bill in 1899 I have, as a consistent believer in the amalgamation of the line and engineer corps, been a most careful student of the flood of criticism of this feature which began to be poured out even before the passage of the bill, and which has continued up to the present day. I have also tried to dispassionately consider the sources from which such criticism has come, and in so doing I believe I find four such, to each of which I desire to give some mention.

First there is the criticism emanating from officers of the old navy (dating prior to the passage of the bill). A careful review of criticisms from such officers reveals the fact that, practically without exception, this unfavorable criticism of the vital feature of amalgamation comes from officers who were not really amalgamated, mainly from old line officers of no engineering experience, who are still deceived by the fog of mystery with which the older engineers were pleased to see their specialty enshrouded, and in a greatly less degree from older engineer officers, who, seeing the present shortage of engineer officers, will not open their eyes to the fact that the personnel bill is not to blame for this shortage, and, therefore, blindly decry amalgamation as the cause of the trouble, whereas it has actually more than doubled the number of available engineers. Such officers as are mentioned refuse to accept the fact, now generally accepted as such, that of the many duties of a naval officer by far the greater part are in mechanical engineering. The technological schools of the country, in preparing a man for any special engineering career, first give him a solid education in general mechanical engineering, and then build on that the specialty which he is destined to pursue. We at the Naval Academy give the same general education, and in addition to that point out the three paths along which progress must be made until those specially fitted for any particular one of the three can determine which two they will leave to follow the other exclusively. Every man of sound mechanical mind, and every thoroughly successful naval officer of to-day must be such, can follow

the three paths together, given the solid foundation for departure which is necessary and which I have shown that we now give. I am sure that this class of criticism is entirely honest and sincere, and that it is advanced solely with a view to increasing the efficiency of the service, but I am convinced by the line of thought that I have tried to set forth in this paper, that it is based on a false groundwork, and is due to a lack of appreciation of the fact that a sea-going officer of to-day, to be a satisfactory all-around man, must be an educated mechanical engineer, and to a failure to comprehend that it is not only possible, but comparatively easy for a man of average ability to do this provided he be guided aright in his younger days.

The second source of criticism is the two service papers, the editors of which are good friends to the service, and have done much good work for it. But their views are purely academic, they being men of no personal experience in the matter. They have, therefore, to base their arguments on the views of others, and unfortunately they have seen very few arguments advanced by the advocates of amalgamation while they have been flooded with the talk of the opposition. Under the circumstances it is not astonishing that the clamor has deceived them and that they have added the influence of their papers to the movement conducted by the classes of officers mentioned in the preceding paragraph.

The third source of criticism is the publications which represent the interests of the merchant marine. These papers, drawing their views largely from officers of merchant ships, could not be expected to do anything but support the system in vogue in the merchant service. Almost anyone will admit, for self-evident reasons, that amalgamation would not be desirable in the merchant marine, but I believe that that is no adequate reason why we should not make use of the higher scientific education which we give our officers in any way that we may see fit. It is submitted that the views of officers of the merchant marine, as expressed through the medium of non-professional editors of maritime journals, are not of great value in deciding upon a proper organization for the commissioned personnel of the navy. These papers, like the service journals, without mature understanding of the principles involved, have seized upon the *Bennington* disaster as a proof of the correctness of their views, without careful inquiry as to whether the situation aboard that ship would have been any better had the line and engineer corps never been amal-

McAboy, Photo.

MACHINE SHOP—GENERAL VIEW

SHOWING GROUP SYSTEM OF ELECTRIC DRIVE, INDIVIDUAL DRIVE, AND BENCH EQUIPMENT

gamated. They drew from that accident the conclusions which they wished to draw.

The fourth source of criticism is the non-professional press; daily, weekly, monthly, and other. Here words fail me, for no man can differentiate their arguments or points of view. It can only be said that the writers for these papers, being entirely non-professional and looking mainly for sensations, of a necessity draw their views, without any special investigation, from such sources as fate may send them, and the products become that emanating from "many men of many minds," and defy analysis.

Before leaving this phase of the subject I wish to state that I have never missed an opportunity in the past to discuss the amalgamation feature with anyone who had any views to present, and the number of such persons with whom I have talked is great. Of this number many have been officers who have had amalgamated experience in full, old line officers who have done engineering duty and old engineers who have done line duty, and of all these men, a class who in my opinion are better able to deliver a sound judgment in the matter than any other, I can count on the fingers of one hand those who are not earnest believers in the amalgamation feature. Almost as a unit they believe that the efficiency of a modern navy depends upon it. I do not mean by this that there are not sometimes objections to some of the details, for there are, the main one being the necessity of taking some steps to supply a limited number of experienced and highly educated designers, but I do mean that as a class these officers believe earnestly in the general principle of amalgamation as enunciated in the personnel bill, provided it be carried out as the bill intended. And I am confident that a vote of the navy, if taken to-day, would find the opponents of amalgamation in a hopelessly small minority.

As a parting word I wish to call attention to one or two facts in regard to the case of the *Bennington*. The commanding officer of this ship was of course one of the older officers of the navy who had never given any special attention to engineering, and who had never been encouraged to do so. He, therefore, trusted to his chief engineer. That chief engineer was a young ensign, recently graduated with a sound groundwork of engineering knowledge, but of insufficient years to enable him to fully appreciate the responsibilities and duties of his position. In the days of the engineering corps no such position was ever held by an

assistant engineer of the same lack of experience. I would, therefore, ask those who are using the case of the *Bennington* as an argument against amalgamation to find answers to the following questions:

(a) Had the commanding officer of the *Bennington* been an officer with engineering education and experience, as those who grow up in the new line must be, would the accident have been more or less likely to happen?

(b) Had the young chief engineer had the word "ensign" in his commission replaced by "assistant engineer," having the same general education and same lack of experience in either case, would the accident have been any less likely to happen?

(c) In view of the answers which must inevitably be found to the above questions, what is there in the amalgamation feature of our present organization that has any bearing on this accident, and how can the accident be attributed to a carrying out of the letter and spirit of the personnel bill?

(d) Given the absolute stupidity that must have been displayed by at least four of the enlisted men who were concerned in the handling of the boiler that exploded, and assuming, as was the case, that the Bureau of Navigation had sent to the ship the best enlisted men for the engineer's force that it had available, was not a prime cause of the trouble the lack of a proper number of experienced enlisted petty officers already referred to, and, if so, what has the amalgamation feature of the personnel bill to do with it?

I ask my readers to seek honest answers to these questions and to base upon them their opinions as to the degree of responsibility for this horrible accident that can be justly placed upon the amalgamation feature of the personnel bill.

In closing this argument, I have to apologize for its length, but the subject is such a large and vital one, and so little has been heard of late from the side to which I belong, that it has seemed necessary, if anything were to be said from this point of view, to say it most completely, and to accompany all arguments by a thorough exposition of the facts on which they are based. I have, therefore, been led to encroach on the patience of my readers to a far greater extent than I desire. My defense must be the great number and the diversified character of the statements of the opposition which I have been compelled to meet.

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THE DRAWING ROOM—NORTH WING

THE DRAWING ROOM—WEST WING

U of M

LIST OF APPENDICES.

APPENDIX.	SUBJECT.
A.	Specimen examination papers of midshipmen of to-day showing highest point of knowledge in each engineering branch to which they attain before commissioning.
B.	Specimen examination papers of naval cadets of engineering branch and line branch between the years 1889 and 1899, when cadets to be commissioned as assistant engineers at the end of the six year course were selected at the end of the first three years and after that given special engineering instruction.
C.	Specimen examination papers of naval cadets between the years 1882 and 1889, when all cadets were given the same course for six years and commissioned at the end thereof into either corps as the number of vacancies demanded; a system the counterpart of the present English scheme of so-called amalgamation.
D.	Specimen examination papers in engineering of cadet engineers and cadet midshipmen prior to the amalgamation of the two branches into naval cadets in 1882.
E.	General statement of requirements for graduation of engineer cadets of the English navy from the engineering school at Keyham prior to the inauguration of the present scheme of amalgamation.
F.	General statement of requirements in engineering for graduation of English naval cadets under the present amalgamation system.
G.	Specimen examination papers in engineering of graduates of a representative Institute of Technology.
H.	Specimen examination papers of applicants for United States license as chief engineer of an ocean-going steamer of unlimited tonnage, with statement of additional requirements necessary to secure United States merchant engineer licenses.
I.	Requirements demanded of applicants for British license as chief engineer of an ocean-going steamer of unlimited tonnage, with statement of additional requirements necessary to secure British merchant engineer licenses.
J.	Statement of officers of the United States navy available for engineering duty as shown by the navy register of July 1, 1905, and as available under the law in force prior to March 3, 1899.

K. Statement of number of graduates of the United States Naval Academy available each year under the present law from which to select engineering experts, and statement of the same under the law in force prior to March 3, 1899.

L. Description of present plant for instruction in engineering at the United States Naval Academy, with statement as to the use made of their facilities.

INTRODUCTION TO APPENDICES.

In these appendices I have endeavored to present the information upon which I have based the opinion expressed in the main paper. For the most part they consist of such examination papers, statements of requirements, etc., as I have been able to get together to enable a judgment to be passed on the relative engineering education possessed by graduates of the United States Naval Academy under the various systems of education in force at that Academy at various periods, by graduates of the English naval engineering schools, under the two systems, by English and American merchant marine engineers, and by graduates of one of the best institutes of technology in the United States.

It is very hard to make a full and complete exposition on this head, and even after occupying as much space as is here given to the matter, much must be left to the imagination. For instance, a good knowledge of the mathematics involved must be assumed under all heads except those relating to the merchant service, as must also a knowledge of mechanical drawing. The amount of practical knowledge required is also most difficult to gage.

However, it is believed that the several appendices touching upon this subject are sufficiently full to enable a careful reader to determine to his own satisfaction, by the exercise of a little judgment, a very fair approximate estimate of the amount of engineering knowledge which must be possessed by a young man starting out in his career under any of the heads given.

In comparing these papers, etc., one must constantly bear in mind the date attached to each one and the degree of inventive progress made in the particular branch up to that date. The efficiency of instruction at any particular date is, of course, the ratio between the ground covered and the ground to be covered, as then known, and it is these ratios for different dates that must be compared, and not the actual ground covered by the different papers regardless of date. This is well shown by the difference in character of the papers of different dates on the science that has made the greatest advances within the last few years, namely, electricity.

In addition to the appendices covering the engineering education of the different classes, I present three others of interest, to which reference is made in the main paper, one being a comparative statement of engineer

officers available in our navy to-day and at the date of the passage of the personnel bill, another a relative statement of the number of graduates available to be worked up into a good engineering personnel on the same two dates, and the third a general, illustrated description of the present outfit and plant available at the Naval Academy for teaching practical engineering.

I desire to call special attention of my readers to the steam engineering examinations set for line cadets at the United States Naval Academy at periods when there were special engineer cadets, as showing that even at the times when the line was not paying much attention to the subject a very good knowledge of engineering was demanded of its cadets.

APPENDIX A.

SPECIMEN EXAMINATION PAPERS OF MIDSHIPMEN OF TO-DAY, SHOWING THE HIGHEST POINT OF KNOWLEDGE IN EACH ENGINEERING BRANCH TO WHICH THEY ATTAIN BEFORE COMMISSIONING.

The subjects included are all those bearing upon the engineering duties of an officer, and are:

1. Mechanics.	Academy Course.	
2. Steam Engineering.	Academy Course.	Boilers and Experimental Engineering.
3. Steam Engineering.	Academy Course.	Principles of Mechanism and Marine Engines.
4. Steam Engineering.	Academy Course.	Marine Engines.
5. Steam Engineering.	Final Graduation.	Marine Engines.
6. Steam Engineering.	Final Graduation.	Boilers.
7. Steam Engineering.	Final Graduation.	Mechanical Processes and Engineering Materials and Designing.
8. Naval Construction.	Academy Course.	Naval Construction.
9. Naval Construction.	Final Graduation.	Naval Construction and Mechanical Processes.
10. Electricity.	Academy Course.	Electricity.

DEPARTMENT OF MECHANICS.

Semi-annual Examination. 2d Class.

Time allowed, 4 hours and 40 minutes.

I.

(a) A 100-pound projectile moving with 2400 f. s. velocity is brought to rest in .01 seconds by a uniform resistance; what was the retardation (in f. s. s.) and what the resistance (in pounds)?

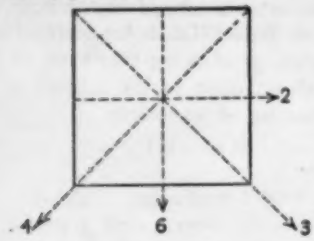
(b) To an observer in a ship moving E. at 15 kts. speed, the wind's apparent velocity is 25 f. s. and its apparent direction N. 30° E.; what are the true velocity and direction of the wind?

(c) A point moves with uniform angular velocity ω in a circle of radius a; find the expressions for its velocity and acceleration parallel to rectang-

ular axes, and show that the total acceleration is $\frac{1}{2}a\omega^2$ directed toward the center of the circle.

II.

(a) Find the resultant of forces of 4 and 9 pounds whose lines of action meet at 30°. What is the tangent of the angle the resultant makes with the 9-pound force?

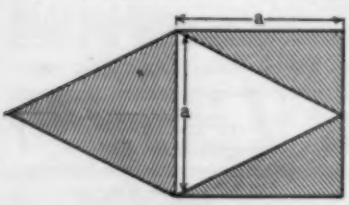


(b) Four forces, 6, 4, 3, and 2 pounds, act along two diagonals and perpendicular to two sides of a square, as shown. Find the value and line of action of their resultant.

(c) Parallel forces 1, 2, 3, 4, and 5 pounds act perpendicularly to a straight line at the respective distances 1, 2, 3, 4, and 5 feet from one end. Find the value and line of action of their resultant.

III.

(a) A uniform boom of weight W is topped up at an angle of 45° by a lift secured to its end and making an angle of 90° with the boom. Determine the tension of the lift and the value and direction of the total thrust on the gooseneck.



(b) Determine the center of uniform pressure of the figure formed by cutting a triangle out of a square of side a and turning it over one side of the square as shown.

(c) Find the center of gravity of the area between the semi-cubical parabola $ay^2 = x^3$ and the double ordinate at $x = a$.

IV.

(a) Find the center of gravity of a solid formed by revolving the area of *IIIc* about *X*.

(b) A weight W rests on a rough plane inclined at 30° with the horizontal; if the coefficient of friction is $\frac{1}{\sqrt{3}}$ what force up the plane will just move the weight up, and what force down the plane will just move it down? What is the least force which will just move the weight up the plane?

(c) A uniform ladder rests against a vertical wall and a horizontal floor making an angle of 60° with the latter. If the coefficient of friction is the same at each end, what is its value if the ladder is just about to slip?

V.

(a) A train weighing 600 tons is moving at 15 miles an hour up a grade of 1 in 200; if the frictional resistance is 10 pounds per ton weight what H. P. is being developed by the locomotive?

(b) What additional H. P. would be required to give the train of (a) an acceleration of ⅛ f. s. s.?

(c) A uniform beam 40 ft. long weighs 1600 lbs. How much work must be done to up end it from a horizontal position?

VI.

(a) A weight W slides from rest down a smooth inclined plane of 30 ft. height and 40 ft. horizontal base; how long will it take and with what velocity and energy will it reach the bottom?

(b) If the plane of (a) is rough and the coefficient of friction is ¼; what will be the time of descent and the acquired velocity and energy?

(c) Deduce the equation to the trajectory in vacuum and determine the horizontal range if the angle of projection is 15° and the initial velocity is 2000 f. s.

VII.

(a) Weights of 11 and 5 pounds are suspended from a cord passing over a smooth peg. What is the acceleration, the velocity after 5 seconds from rest, and the pressure on the peg?

(b) A 10-pound weight resting on a smooth horizontal table and connected to a fixed point on the table by a cord 5 ft. long is describing a circle with a velocity of 40 f. s. What is the tension of the cord?

(c) Determine the radius of gyration of a circular area of radius a about a diameter and thence find its value about a tangent.

VIII.

(a) Determine the radius of gyration of a right cone about its axis.

(b) A cylinder of 4-in. radius and weight 200 lbs. is free to rotate about its axis, and a force of 1000 lbs. is applied to its surface tangentially; what will the angular acceleration be and what the angular velocity 5 seconds from rest? What is the energy of rotation when the cylinder is making 150 turns a second?

(c) A ball weighing 10 pounds, moving at 10 f. s., impinges directly upon another weighing 5 pounds which is at rest; if the coefficient of restitution is 4/5, what are the velocities after impact?

DEPARTMENT OF MECHANICS.

Annual Examination. 2d Class.

Time allowed, 4 hours and 40 minutes.

I.

(a) Define *stress, strain, modulus* of *elasticity* and *elastic limit.*

(b) If a steel rail laid at a temperature of 60° F. is prevented from contracting by fastening the ends, under what stress will it be at 24° below zero (coefficient of expansion for 1° F. is .0000065)?

(c) A cylindrical test piece, 2 in. in diameter and 10 in. between fillets stretches .0137 in. under a load of 125,664 lbs; what is the modulus of elasticity of the material?

II.

(a) A cylindrical water pipe of 48 in. diameter is made from ½ in. thick steel plates. If the efficiency of the riveted joints is 84%, what internal pressure will the pipe stand, supposing the limiting stress is 12,000 lbs. per sq. in.

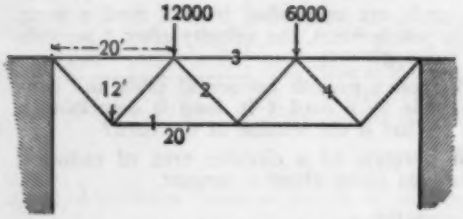
(b) State the value of the maximum S. F. and B. M. and the positions at which they occur, in the case of a beam 12 ft. long, supported at the

ends, 1st, when it carries a concentrated load of 240 lbs., 4 ft. from the left end; 2d, when it carries a uniformly distributed load of 40 lbs. per ft. run.

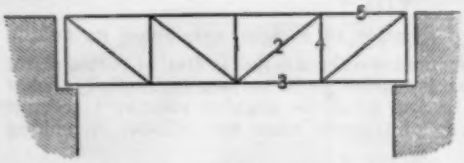
(c) State the values of the maximum S. F. and B. M. and the positions at which they occur, in the case of a beam 6 ft. long, fixed at one end; 1st, when it carries a concentrated load of 240 lbs. at its center; 2d, when it carries a distributed load of 40 lbs. per ft. run.

(d) How would you find the maximum B. M. in cases (b) and (c) if the beam carried *both* its concentrated and its distributed load?

III.

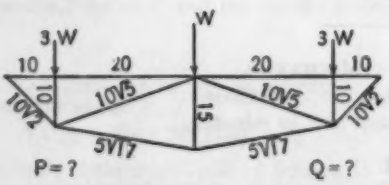


(a) A girder of 60 ft. span and 12 ft. depth is loaded as shown; using method of sections, find the value and kind of stress on each of the four members marked and numbered.



(b) And N girder of four panels, each 25 ft. wide by 20 ft. deep, carries a uniformly distributed load of 1000 lbs. per ft. run on the upper boom. Using the method of sections, find the value and kind of stress on each of the five members marked and numbered.

IV.



(a) Draw the R. D. of the two frames of III and thence determine the stresses in the marked members.

(b) Draw the R. D. and thence find the *value* and *kind* of stress on each member of the frame shown. *Double-line in frame diagram all members which act as struts with the given loading.*

V.

FIG. 1.

(a) Determine the neutral axis of the beam, section shown (Fig. 1).

(b) Determine the moment of inertia about the neutral axis for the beam, section shown (Fig. 2).

(c) How long must a cast iron bar 2 in. square be in order to break under its own weight when supported as a simple beam at its ends, supposing the breaking stress is 20,000 lbs. per sq. in. (A cu. in. of cast iron weighs .26 lbs.)

FIG. 2.

VI.

(a) A uniform beam a ft. long between supports carries a distributed load of w lbs. per ft. run. Deduce the general expressions for the S. F., B. M., slope, and deflection, and find their maximum values, stating where each occurs.

(b) Find the maximum fiber stress and the maximum deflection of a plank, 12 in. wide by 1 in. thick and ten ft. (10′) between supports, due to a weight of 30 lbs. at its center. (Take $E = 1{,}500{,}000$ lbs. inches.)

VII.

(a) Determine the pitch of the rivets in a single riveted lap joint in order that the resistances to shearing and tearing may be equal. (Tensile strength 6/5 shearing strength.)

(b) A double riveted lap joint of 7/16 in. steel plates has rivets of 1 in. diameter with a pitch of 3⅝ in. What pull on each repeating section would cause the failure of the joint; 1st, by tearing the plate; 2d, by shearing the rivets? (Tensile strength 60,000, shearing strength 50,000 lbs. sq. in.)

(c) What would be the pitch of the rivets for a treble riveted, double butt strap, joint between ¾ in. steel plates, using 1 in. rivets and taking tensile strength of plate 6/5 shearing strength of rivets?

VIII.

(a) Deduce the expression for the maximum shearing stress (q_s) on the right section of a hollow cylindrical shaft (inner radius r_1, outer radius r_3) under the action of the twisting moment $T = aF$.

(b) What is the relation between the twisting moment ($T = a\,F$) applied to a uniformly rotating shaft and the horsepower it develops at n turns per minute?

(c) What is the maximum shearing stress on a steel shaft of 2 in. diameter, transmitting 20 H. P. at 120 turns per minute?

DEPARTMENT OF MARINE ENGINEERING AND NAVAL CONSTRUCTION.

Semi-annual Examination. First Class.

Boilers and Experimental Engineering.

Time allowed, 4 hours and 40 minutes.

I.

Sketch and describe the Ward steam launch boiler.

II.

Make neat and clear line sketches of the Babcock and Wilcox and the Niclausse boilers, showing the courses of the water and the steam and of the gases of combustion.

III.

(a) Given the stroke of an engine 4 feet and cut-off at half stroke when the connecting rod is infinite in length, what would be the cut-off for both strokes of this engine with a connecting rod 8 feet in length? Graphic solution required. What must be done to the valve to counteract this effect of the connecting rod?

(b) Tabulate the information that can be obtained from a complete Zeuner valve diagram.

(c) Describe the method of setting a slide or a piston valve, there being no marks on the engine to assist you. Explain briefly, but clearly, each step in the operation.

IV.

(a) Define the terms "effective horsepower" and "propulsive coefficient." In a well designed ship what should be the value of the "propulsive coefficient"?

(b) What do you understand by the term "engine" or "mechanical" efficiency. What value is given to "engine efficiency" in a well designed modern engine?

(c) Explain the distribution of the total power of a modern high-speed engine and give the approximate percentage values for the different elements.

(d) Show briefly why excessive waste ensues in running a high-powered engine at low powers made necessary for cruising conditions, and why it is difficult to obtain good propulsive efficiency under these conditions.

V.

(a) Define the following terms with reference to screw propellers: fraction of the pitch; angle of the screw; right-hand propeller; pitch ratio; apparent negative slip.

(b) Tabulate briefly the advantages of twin screws.

(c) What are the advantages of propellers fitted with separate blades secured to the hub?

(d) Briefly describe the modified Griffith's screw as used in the U. S. Navy, shape, etc. How are the blades secured to the hub?

VI.

(a) If you find that you require no make up feed water and water in the feed tank is increasing, what examinations would you make?

(b) With low water or water out of sight in your boilers, what action would you take? State briefly your answers, as your action would require quickness.

(c) What is priming in boilers? Give the causes of priming and show how these causes produce priming.

(d) How is priming checked?

VII.

(a) Upon what does the amount of "make up feed" required depend?

(b) Roughly, what should be the amount of "make up feed" per 1000 I. H. P. on a ship with well designed engines in good condition?

(c) Tabulate the causes of hot bearings.

(d). What action should be taken with warm and with hot bearings?

(e) How do you adjust a main crank shaft bearing? Explain in detail.

(f) How do you refit a journal and bearing that has been running hot?

VIII.

(a) Sketch and describe any type of air pump in which foot and bucket valves are not needed. Vertical section required.

(b) What are the advantages of independent air pumps? In engine tests why should the barometric height be taken along with the reading of the vacuum gage?

(c) Make a sketch (vertical section) of an air pump valve on its seat, complete with all fittings and attachments.

(d) Of what are air pump valves made? What is the usual lift of such a valve? What is the effect of too great lift with high speeds?

IX.

(a) State briefly the general arrangement used in estimating the number of commissioned officers, warrant officers, petty officers, firemen, and coal passers to be assigned to a battleship or large armored cruiser.

(b) What tests, examinations, or requirements would you make on receiving any of the following stores, to see that they were of proper quality and suitable to be received: (1) Cotton waste; (2) engine mineral lubricating oil; (3) lard oil; (4) red lead dry; (5) sheet gum gasket?

X.

Sketch the ash hoist engine in general use in the U. S. Navy, and briefly describe its action.

DEPARTMENT OF MARINE ENGINEERING AND NAVAL CONSTRUCTION.

Semi-annual Examination. Second Class.

Principles of Mechanism and Marine Engines.

Time allowed, 4 hours and 40 minutes.

I.

(a) Define "throw of the eccentric," "lap," "lead," "angle of advance," "center of oscillation," "simple pendulum," "circle of curvature," "similar curves."

(b) Deduce the relation between the angular velocities of the cranks in the four bar motion, and state the theorem.

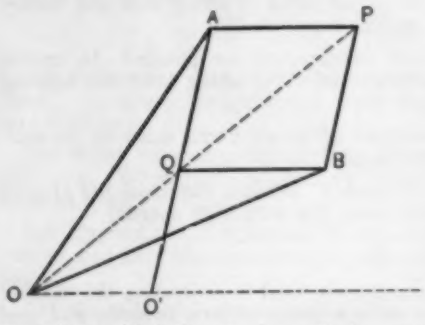
II.

(a) The equation of a cam is $r = 5\theta^2$ (measurement in inches). How high will the lifting rod be raised from its lowest point when the cam is moved through 10 deg.? Also, what will be the velocity of the rod at that instant if the cam be revolving at the uniform rate of 5 revolutions per minute?

(b) Sketch and describe a machine for rifling guns, in which the combination of three pulleys with three bevel wheels is used. Show clearly and explain the working of the bell crank lever that shifts the belt.

III.

(a) Sketch neatly and describe the hand machine for cutting metals, and deduce the relation between the force applied and the power produced, giving numerical example.



(b) The figure shows Peaucellier's exact parallel motion. The rods AP and QB are horizontal and parallel to OO'. $O'QA$ is a straight line. The distance from O to the foot of the perpendicular let fall from P on OO' extended is 9"; $OA = 8"$, and $AQ = 4"$.

(1) Construct to scale the exact parallel motion, and (2) determine the radius of the curve that P would draw if OO' be made equal to $2O'Q$, as found by the preceding construction. (Solution to be entirely graphical.)

IV.

(a) (1) A wheel 4 ft. in diameter runs at a velocity of 50 miles an hour. What pull will 7 pounds on the rim exert, supposing the wheel to be out of balance to that extent? Sketch and describe a machine that will obviate this trouble.

(2) Briefly discuss the analogy between a common suction pump and a ratchet bar.

(b) Show how to form the teeth on bevel wheels by Tredgold's method.

V.

(a) Sketch and briefly describe a Nason steam trap, giving the details of its action, the material of which made, and the purpose for which it is used.

(b) Explain briefly how flanges are attached to copper and to steel pipes, giving the material of which the flange is made in each case.

(c) Give the requisites for a tight joint between two lengths of steam pipe.

VI.

(a) Define gear wheels. Pitch of a wheel.
What are cycloidal teeth and when used?
What are involute teeth and when used?
What is diametral pitch?

Values of M.....	5	6	7	8	9	10	12
Values of P.....	.628	.524	.449	.393	.349	.314	.262

Given diameter = 9 inches. $N = 108$. Determine pitch P.

(b) Annular wheel for turning turret, diameter of pitch circle to be approximately 12 feet, linear velocity of a point in pitch circle 47.124 feet per minute, pitch of all gearing = 2.0944 inches.
Find diameter of pitch circles and number of teeth on the pinion such that the pinion will make 45 revolutions per minute.

VII.

(a) Devise a lifting crab with two axes, such that a man exerting a pull of 40 pounds can lift two tons. (One ton = 2240 pounds.)

(b) Leading screw of a lathe has 6 threads to the inch, and the wheel on it has 60 teeth. The pinion on the end of the mandrel has 24 teeth; these two wheels are fixed. The other two wheels are change wheels, 12, 18, 36, 48. Make a table showing what threads the lathe will cut.

VIII.

(a) In a Whitworth friction drill, the drill revolves 228 revolutions per minute; the thread is 12 to the inch; the friction wheels contain 24 teeth each. How many revolutions must the friction wheels make in order to cause the drill to feed one inch per minute.

(b) Prove that the sun and planet wheel can not be an exact substitute for the crank and connecting rod.

IX.

(a) Sketch and describe a Roet's blower.

(b) Sketch and describe Siemens' epicyclic governor for a steam engine.

X.

(a) Sketch and describe a slip or expansion joint as fitted to a steam pipe; describe its use.
Sketch an atomizing oil burner, using compressed air as the atomizing agent.

(b) Sketch in section one upper tube of a Niclausse boiler, showing the connections with the headers and drum; also showing in detail the lantern and designating by arrows the circulation of the water.

DEPARTMENT OF MARINE ENGINEERING AND NAVAL CONSTRUCTION.

Annual Examination. Second Class.

Marine Engines.

Time allowed, 4 hours and 40 minutes.

I.

(a) What is the efficiency of the propelling apparatus? Where do the losses occur, and give the approximate values of the various factors from which the "total efficiency" is calculated?

(b) With steam working between the limits of temperature of 401° F. and 141° F., what could be the greatest possible efficiency of the steam?

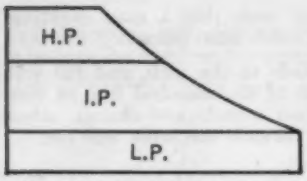
(c) Sketch a vertical section through the center of a piston, showing how it is secured to the rod, the method of securing the rings and the follower, and sketch a method of making the rings tight at the joints.

II.

(a) State in detail the cause of liquefaction in the cylinders and what methods are employed to reduce the loss.

(b) Sketch a differential reversing valve with distributing valve for a steering engine and show clearly the path of steam and exhaust for each direction of rotation.

III.



(a) The diagrams from a triple-expansion engine when combined show the unequal distribution of work as in the figure. State explicitly what you would do to increase the work in the H. P. and L. P. cylinders so as to equalize the work, and sketch roughly the combined card after the adjustments have been made.

(b) Make a line sketch and explain the action of the Edwards' air pump.

IV.

(a) Make a sketch of the indicator card of a simple condensing engine and indicate on the sketch the following lines and points: Atmospheric line, clearance lines, line of boiler pressure, admission line, steam line, point of cut-off, point of release, back pressure line, exhaust line, expansion curve, compression curve-point of exhaust closure.

(b) Sketch and explain the independent linking-up gear and show why the engine will reverse full gear when running linked in.

V.

On the extra sheet the valve check, crank circle, and length of connecting rod are given: Scale of rod and crank circle 1½ in. = 1 ft. Scale of valve circle 6 in. = 1 ft. Rotation counter clock wise.

(a) Top cut off 16.8 in. from end of stroke. Steam load = ½ in., exhaust lap = ¼ in.

(b) Bottom admission ¼ in. from beginning of return stroke, exhaust lap = 0.

Show on the valve diagram the following points for both ends of valve, cut-off, release, compression, admission, opening to steam when valve is at end of travel.

VI.

(a) Show by sketch and explain how the length of the connecting rod would effect the distribution of steam if the valve were the same at each end.

(b) Show the effects on the indicator cards (both ends of cylinder) in the following cases: Insufficient angular advance, valve stem too long, valve stem too short, excessive steam lap.

State in each case what points are effected.

VII.

(a) Show how the dynamometrical horsepower is calculated by means of the Prony brake. How is the mechanical efficiency of the engine calculated by this means.

(b) Give briefly the principle of the action of the steam in the three types of steam turbine: DeLaval, Parsons, Curtis.

(c) Why should a good vacuum play such an important part in the economy of the steam turbine, or why can the steam turbine employ more effectively a good vacuum than the reciprocating engine?

(d) How is the power of a turbine measured?

VIII.

(a) There being no marks on the engine, explain how you would set a slide valve from the data furnished by the valve diagram of the engine.

(b) Sketch and explain the evaporator commonly used in the navy.

IX.

(a) State what you would do under the following circumstances: Piston rod hot, crank pin bearing running warm, main bearing hot, too much feed water, water out of sight in shell boiler, boiler priming, split tube in a water-tube boiler.

(b) State in detail and in proper order the work done in the engine room in preparing to get under way.

X.

Describe the method of making steel from the raw ore, using the acid Bessemer converter in the final step.

U. S. NAVAL ACADEMY.

DEPARTMENT OF MARINE ENGINEERING AND NAVAL CONSTRUCTION.

Final Examination of Midshipmen.

Subject: Marine Engines.

Time allowed, 7 hours.

I.

(a) Sketch the method of keeping the piston of a large marine engine steam tight.

(b) Describe the piston rod packing. What are reducing valves? Where are they applied and for what purpose?

II.

Explain briefly and illustrate by sketch the method of packing condenser tubes. How are the tubes prevented from slipping or crawling? How do you determine if a condenser is leaking? How do you find out the leaky tubes, and how do you proceed to stop the leaks?

III.

(a) Make a sectional view of the water end of the vertical air pump used with modern engines, showing the valve and the piston or bucket, and briefly describe.

(b) How do you determine the slip of a screw propeller, having given the speed of the ship, revolutions per minute, and pitch of screw? How do you measure the pitch of a screw propeller?

IV.

State briefly the various steps taken to warm up the engines and auxiliaries of a high-powered vessel and get everything ready to turn the engines. Steam on the boilers.

V.

(a) State in detail the method of starting the main air and circulating pumps preparatory to getting under way.

(b) State the procedure with the main engines and auxiliaries on receiving the order to "Bank fires and secure the engines."

VI.

(a) Fires having been started preparatory to getting under way, state what you would do in the engine rooms to insure that the machinery will be ready and in proper condition at the time fixed for starting.

(b) How secure the engines after coming to anchor.

VII.

(a) Trace the course of the feed water from the feed tank through the boilers and engines, and back to the feed tank, tabulating all pipes, valves, and other parts that the water or steam passes through with a triple-expansion engine.

(b) Of what material is each of the following parts made: Crank shaft, cylinder, piston, bedplate, screw propeller, piston valves, circulating pump casing, runner, runner shaft bearing?

VIII.

(a) Sketch and describe the centrifugal circulating pump and state the principle of its action; how the water enters and leaves it; how the pump is operated, and name the usual connections to a circulating pump.

(b) State briefly the advantages of the centrifugal circulating pump, and briefly give the advantages of an independent air pump.

IX.

(a) Describe briefly the special work that should be done in the engineer's department when the ship is in drydock.

(b) How would you measure the pitch of a screw propeller in dock? Describe briefly the operation. (Propeller on the shaft.)

X.

(a) Briefly describe the action of the Parson's steam turbine, illustrating by sketches where necessary. How is reversibility obtained in the Parson's steam turbine?

(b) Roughly, what is the relative number of expansions in the triple-expansion reciprocating engine and the steam turbine, both using the same initial and condenser pressure?

(c) How are the bearings in a steam turbine lubricated?

XI.

(a) What effect upon the steam distribution have the following defective adjustments, or construction of the steam distributing valve:

(A) Excessive angular advance.
(B) Insufficient angular advance.
(C) Excessive steam lap.
(D) Insufficient steam lap.

(b) State in detail the preparations made in the engineer's department for coaling ship, and in securing after coaling is completed.

(c) Explain the method of testing the tubes of a surface condensor and how to locate any tubes that may be leaking.

U. S. NAVAL ACADEMY.

DEPARTMENT OF MARINE ENGINEERING AND NAVAL CONSTRUCTION.

Final Examination of Midshipmen.

Subject: Boilers.

Time allowed, 4 hours.

I.

(a) How does the evaporative power of liquid fuel compare with that of coal?

(b) Sketch and describe an expansion joint for steam and explain its use.

(c) How many cubic feet of bunker space are usually allowed per ton of coal?

(d) Sketch and describe a separator, explain its use and where placed.

(e) What are stay tubes? How are they secured in place? Why are they used and how do they differ from an ordinary boiler tube?

II.

(a) Sketch and briefly describe a Niclausse water-tube boiler, and indicate by arrows the course of the products of combustion and the passage of the water in its conversion into steam.

(b) Make an enlarged sectional sketch of one complete tube in a Niclausse boiler connected to the header, and briefly explain the connection.

(c) What constitutes the heating surface of a boiler? What is the ratio of heating surface to grate surface in a Scotch boiler?

III.

(a) State the principal causes of corrosion in marine boilers, and state what means are at present employed for its prevention.

(b) Of what does boiler scale consist? Where is it most objectionable? How is it removed? How is it prevented? What evil effects are produced by it?

IV.

Briefly describe the following processes—ship underway:

1st. Firing a furnace.
2d. Cleaning fires.
3d. Sweeping tubes.
4th. Starting an additional boiler.
5th. Disconnecting a boiler.

V.

Briefly describe the methods used in vessels of the U. S. Navy for forced draft. What is the object or advantage in forced draft installation.

U. S. NAVAL ACADEMY.

DEPARTMENT OF MARINE ENGINEERING AND NAVAL CONSTRUCTION.

Final Examination of Midshipmen.

Mechanical Processes, and Engineering Materials and Designing.

Time allowed, 4 hours.

I.

(a) Define cast iron, wrought iron, and steel. Describe briefly the characteristics of each.

(b) What is brass? What is bronze? Give some examples of the use of the brasses and bronzes.

(c) What is nickel-steel and what are its characteristics?

(d) State briefly the influence of the following elements in iron, viz.: Carbon, silicon, sulphur, phosphorus, and manganese.

II.

Describe briefly the forging and machining of a large single-throw steel crank shaft, such as is used for a section of the shaft of a triple-expansion marine engine, naming the tools and appliances used.

III.

(a) What are solid drawn tubes? How are they manufactured, of what material are they made, and what are the limits of size?

(b) Describe briefly the tempering of steel.

(c) What is tempering in oil, how is it done, and when is this process of tempering used?

(d) What is case hardening and how is it done?

IV.

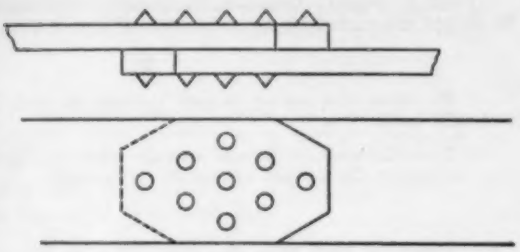
(a) An engine developes 6500 I. H. P. when making 130 revolutions per minute. The maximum twisting moment is 1.4 times the mean. The propeller weighs 20,000 lbs. and its center is 40 in. from the strut bearing. Required the diameter of the hollow steel propeller shaft, the diameter of the hole being one-half the external diameter. Safe strength of material 9000.

(b) The diameter of a shaft is 16 in.; axial hole is 8 in. The flange coupling has eight bolts and the diameter of the pitch circle of the coupling bolts is twice the diameter of the shaft. Required the diameter of the bolts.

V.

(a) The depth of a back connection of a cylindrical boiler is 30 in.; the girder stays are pitched 12 in. Each girder consists of two steel plates each ¾ in. thick. Boiler pressure 180. Strength of material 9000. Required the depth of the girders.

(b) A tie rod consists of two 4 in. × ½ in. flats riveted to each other as shown. f equals 6000. f_s equals 5000. Diameter of rivets is ¾ in. Find strength of joint against each possible fracture, neglecting crushing, and the efficiency of the joint.



DEPARTMENT OF MARINE ENGINEERING AND NAVAL CONSTRUCTION.

Semi-annual Examination. First Class.

Naval Construction.

Time allowed, 4 hours and 40 minutes.

I.

(a) Define the following terms: Displacement, center of buoyancy, metecenter, metecentric height, statical stability, dynamical stability, and tons per inch immersion.

(b) Write down Simpson's first and second rules for finding the areas of plane surfaces and state under what condition each rule is applicable.

(c) Explain clearly how the work of computing the displacement from the shear draft may be much shortened by the use of the planimeter.

II.

(a) What is meant by the expression "Moment to Change Trim"? Deduce the expression for the moment to change trim one inch; given, displacement 14,000 tons, longitudinal metacenter 500 ft. above the center of buoyancy, distance between the center of gravity and center of buoyancy 13 ft., length of ship 405 ft., find the change of trim caused by the longitudinal transfer of fifty tons through 150 ft.

(b) Given the drawings composing the shear draft, show how, by means of these and the inclining experiment, it is possible to locate the vertical position of the center of gravity.

III.

(a) Deduce Attwood's formula for statical stability at large angles of inclination.

(b) Show how to construct the curve of statical stability and state the information that can be obtained from it.

(c) What are cross curves of stability, and how are they constructed?

IV.

(a) Describe the rolling experiment, stating how and for what purposes it is made.

(b) State the conditions under which dangerous rolling might be expected when a ship is steaming among the waves, and give the proper steps to take to remedy this.

(c) Show how to measure the length and height of a wave. Why is the height estimated by an untrained observer usually too great?

V.

(a) Describe the scrive board, stating its use, location, and the lines it should have.

(b) Describe clearly the method of bending a frame angle iron, showing how to ensure the proper curvature and bevel.

VI.

(a) Describe and give the uses of the following: Tie plate, deck stringer, deck beam, sheer strake, stanchion, bracket plate, tap rivet, and cofferdam.

(b) State the tests to which steel ship plates and rivets are subjected, giving a brief description of each. What is done to plates that are liable to be immersed in sea water before they are built into the ship? Describe the process briefly.

VII.

Make a sketch of the midship section of a battleship, showing the position of floor plates, longitudinals, main and reverse frame angle irons, flat and vertical keel plates, keelson, garboard, and other strakes of outside, showing how the different parts are secured together and stating particularly with regard to frames and longitudinals, which parts are continuous and which parts are worked intercostally.

VIII.

(a) Explain fully the water-tight subdivision of a battleship, and state clearly how the different compartments are distinguished and designated.

(b) Describe the method of working a transverse water-tight bulkhead, showing clearly how it is secured so as to be water-tight at its edges, and how strengthened so that it will withstand the pressure due to a compartment on one side being filled with water.

IX.

Describe the framing, plating, and backing behind the side armor, making sketches where necessary, and show how the armor is gotten into its proper position and secured.

X.

Describe clearly and concisely, giving only necessary details, the drainage, pumping, and ventilating systems of a battleship.

U. S. NAVAL ACADEMY.

DEPARTMENT OF MARINE ENGINEERING AND NAVAL CONSTRUCTION.

Final Examination of Midshipmen.

Subject: Naval Construction and Mechanical Processes.

Time, 3 hours.

I.

(a) Describe the inclining experiment. How made and for what purpose.

(b) State briefly the method of numbering and lettering compartments of vessels in the U. S. Navy, and locate the following: A-97, B-106, C-2, D-94.

II.

(a) What precautions are taken in the bilges to prevent corrosion? When rust cones are formed under paint, how is further corrosion prevented? How is metal prepared to receive cement.

(b) What is meant by a 20-lb. iron plate?
How is sweating prevented in a steel ship?
What is a sheathed ship? A composite ship?

III.

(a) What curves are furnished a vessel by the Bureau of Construction and Repair, and explain their uses?

(b) What is the effect on the period of a ship in moving weights from amidship outboard?

(c) Sketch the different keels used in steel ship construction.

(d) What effect have bilge keels on the period and arc of oscillations?

(e) What paints are used on the outer bottom of ships?

IV.

(a) Define the following foundry terms: Green sand, loam, core print. Draw a diagram to show the location of the gates, etc., in making a mould.

(b) What is meant by "chilled" castings, and how are they made?

(c) How are patterns made? What is meant by the "shrinkage rule"? What is plate moulding?

V.

(a) Describe the process of welding two pieces of wrought iron together? What is used as the flux in steel welding?

(b) Describe clearly the method of brazing a brass flange on a copper pipe. What is spelter, and of what is it composed?

VI.

(a) Describe briefly but clearly the method of making a "surface plate"?

(b) Describe briefly the following processes: Tempering, case-hardening, and hardening in oil.

SEMI-ANNUAL EXAMINATION. FIRST CLASS.
Subject: Electricity.
Time allowed, 4 hours and 40 minutes.

I.

(a) The sounder and decoherer of the larger receiver of the wireless telegraph outfit are joined in multiple arc with a battery of 5 volts E. M. F. and 2 ohms internal resistance. If the resistance of the decoherer is 4 ohms and of the sounder 3 ohms, what is the current strength through each?

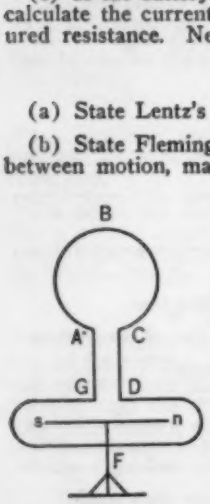
(b) Make a sketch of some commercial form of a Wheatstone bridge and show clearly all the connections, including battery, galvanometer, and keys, for the measurement of a resistance of 9.4 ohms. Show what plugs are cut when a balance has been obtained.

(c) If the battery has an E. M. F. of 6 volts and resistance of 12 ohms, calculate the current strength through the battery and through the measured resistance. Neglect resistance of leading wires.

II.

(a) State Lentz's law of electro-magnetic induction.

(b) State Fleming's or some other rule for remembering the connection between motion, magnetism, and induced current.



(c) What application has Fleming's rule if the left hand be used?

(d) Show by an arrow the direction of the induced current if the south-seeking pole of a bar magnet be inserted into the ring *ABC* from this side of the paper.

(e) State also whether the induced current would tend to deflect the end *n* of the magnetic needle as suspended in the plane of the loop *DFG*, which is a continuation of *ABC*, out from or back through the paper.

(f) Suppose a current be flowing in the direction of the motion of the hands of a watch in a coil placed behind *ABC* and parallel to it. If this current be broken, in which direction through *ABC* will the induced current flow, and which end of the needle will tend to come out through this side of the paper?

III.

(a) State two important laws of thermo-electricity.

(b) Describe a thermo-electric pile of several pairs.

(c) What do you understand by thermo-electric inversion; give an illustration.

(d) What are Joule's laws of the heating effect of a current?

(e) Find the diameter of a lead safety catch for a circuit of fourteen lights, each taking 0.6 ampere, and allowing a margin of 25%. The specific resistance of lead is 19 michroms, melting point 335° C., loss of heat by radiation and convection per unit of surface 0.001 Joule per second for each degree difference of temperature. Take the temperature of the room to be 18° C.

(f) Is the length or specific heat of the safety catch of importance? Why?

IV.

(a) Describe the transformer used in lighting houses with alternating current, and its connection with the mains.

(b) To get, say 100 amperes at 50 volts from the secondary, what is the least current and E. M. F. that must be supplied to the primary?

(c) How is it that this system is self-regulating, and that less energy is supplied when lights are turned off?

(d) How may polyphase currents be obtained?

(e) How may a rotatory magnetic field be produced?

(f) Describe a microphone, a Blake carbon telephone transmitter, a transmitter of granulated carbon, and a Graham Bell receiver.

V.

(a) Connect a battery, call bell, and push button, showing electric magnet, hammer, spring, and everything ready for use so that the bell will ring if the button be pressed.

(b) Let there be two telegraph stations, *A* and *B*, each supplied with battery, sounder, relay, and key. Make a sketch showing instruments and stations connected so that all is ready for *A* to telegraph to *B* or *B* to *A*.

(c) What do you understand by electric oscillations in the discharge of a condenser?

(d) What changes in a condenser will slow down the oscillations of discharge?

(e) How did Hertz produce electric waves?

(f) Mention several ways of detecting these waves at a distance.

VI.

(a) What is a dynamo electric machine, and what two distinct functions is every dynamo electric machine capable of serving?

(b) Upon what three factors does the E. M. F. at which a dynamo delivers its current depend?

(c) By diagram and description, show the winding, polarity, direction of rotation of the armature, and direction of the currents in a shunt dynamo.

(d) What will be the effect on a series and on a shunt dynamo (1) if the lamps be added in series, (2) if lamps be added in multiple arc?

VII.

(a) Define unit magnetic pole, intensity of magnetic field, torque, numerical value of horsepower in watts, ampere turns, lost volts, lost amperes, dead turns, spurius resistance, hystereris, eddy currents.

(b) What is the function of the iron core of a transformer?

(c) Suppose a forward lead is given to the brushes of a dynamo for the purpose of stopping sparkling, what reaction follows?

(d) Why is it easier to start a shunt dynamo (that is get its normal E. M. F.) with the lamp circuit open, than with it closed?

(e) Show by a sketch the difference between a short and a long shunt dynamo.

VIII.

(a) Compare, using descriptions and diagrams, series, shunt, and compound wound dynamos, (A) their construction, (B) their uses, and (C) their regulation.

(b) What is meant by overcompounding?

(c) Make a diagram showing total and external characteristics of a dynamo.

(d) State what they mean and how one may be obtained from the other.

(e) How may horsepower lines be added?

(f) Given a series dynamo of 9 ohms resistance (internal), a current of 12 amperes was sent through an external resistance of 72 ohms by the application of 18 H. P. to the shaft. Find the electrical and commercial efficiencies of the dynamo.

IX.

(a) Give a method for securing a proper voltage for a searchlight from a ship's 80 volt or 110 volt circuit; also method of obtaining lower voltage for bell or other circuits.

(b) How are ground detector lamps or a ground detector voltmeter connected on a switchboard, and how are leaks indicated?

(c) What is the difference between an ammeter and voltmeter, and how is each connected with an electric circuit?

(d) How is a series shunt applied to a compound wound dynamo, how is its resistance changed, and what is its use?

(e) For what purpose is a series motor better than a shunt motor and for what purpose is a shunt motor better than a series motor?

(f) How may the direction of rotation of the armature of a simple series motor be reversed?

(g) What is the difference between the law concerning the maximum activity of a motor and the law of maximum efficiency?

X.

(a) The resistance of the armature of a shunt dynamo is .008 ohm, and that of the field 58 ohms. If the difference of potential at the terminals is 395 volts and the current in the mains 516 amperes, calculate the lost volts, lost amperes, and heating effect in armature and in shunt. If the commercial efficiency is 92%, what power is applied at the shaft?

(b) Given, a compound wound short shunt dynamo with difference of potential at brushes of 110 volts and resistance of series coils .04 ohm; how far away on mains having a resistance of .06 ohm per thousand feet will a branch circuit of 125 glow lamps in parallel be supplied, each lamp requiring 0.8 ampere and having a resistance of 106 ohms each?

XI.

(a) Show how series and compound wound dynamos may be safely connected in parallel, and what accidents may occur if proper precautions are not taken.

(b) How are dynamos connected for the three-wire system of electric lighting, and what advantages has this system?

XII.

Sketch and describe the sending and the receiving apparatus for wireless telegraphy. What parts should be grounded and what carefully insulated?

APPENDIX B.

SPECIMEN EXAMINATION PAPERS OF NAVAL CADETS OF ENGINEERING BRANCH AND LINE BRANCH BETWEEN THE YEARS 1889 AND 1899, WHEN CADETS TO BE COMMISSIONED AS ASSISTANT ENGINEERS AT THE END OF THE SIX-YEAR COURSE WERE SELECTED AT THE END OF THE FIRST THREE YEARS AND AFTER THAT GIVEN SPECIAL ENGINEERING INSTRUCTION.

1. Steam Engineering. Academy Course. Engineering Branch.
2. Steam Engineering. Academy Course. Line Branch.

DEPARTMENT OF STEAM ENGINEERING.
Annual Examination.
Naval Cadets. First Class.
Engineer Division.

Boilers.

Data furnished: Displacement, 1000 tons. I. H. P., 1700. Steam pressure per gage, 160 lbs.

Coal used per square foot of grate surface per hour, 41 lbs. Forced draft.

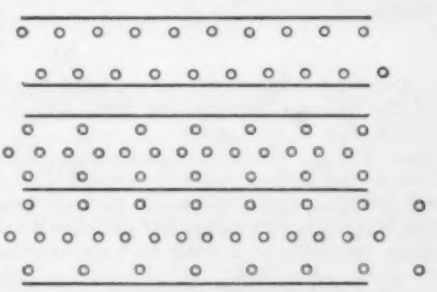
Coal used per I. H. P. per hour, 2.41 lbs. Fox furnaces.

Head sheets curved back to a radius of 26½ in.

Circumferential seams, double zigzag riveted.

Longitudinal seams, treble zigzag riveted.

Material, mild steel, 60,000 lbs.



I.

(a) Decide the type of boilers used and the approximate diameter and length.

(b) Determine the grate surface, length of grate, diameter of furnace, number of furnaces, length of furnace, and thickness of furnace sheet.

II.

(a) Determine the depth of the combustion chamber, length of tubes, and length of boiler. Care must be taken to allow space for withdrawal of tubes.

(b) Determine the total heating surface, the tube surface, the number of tubes (2 in. diameter), and make a neat line sketch, showing arrangement of tubes in tube sheet with stay tubes.

III.

(a) With riveted joints, as shown, determine the percentage strength of rivets, of plate, and of both combined.

(b) Using the percentage as found, find the thickness of shell plates, of butt-straps, diameter and pitch of rivets.

IV.

(a) Determine the thickness of the head sheets and of the combustion chamber sheets. What considerations determine the thickness of the latter?

(b) Find the diameter of the steam space stays which are spaced 14 inches.

V.

Make a vertical longitudinal and a half cross section of the boiler with dimensions as found, showing arrangements of sheets and joints (three courses in shell, each 5 ft. 9¼ in. wide), furnaces combustion chambers, tubes, stays, and girders. Scale, ¾ in. = 1 ft.

VI.

(a) Make a neat line sketch of the principal manhole in the cylindrical shell near the top, and give all dimensions on the sketch. Why is the hole of the size given, the major axis placed as it is, and the doubling plate of the dimensions given?

(b) Make neat line sketch of section of manhole plate with all attachments.

VII.

The lower edge of the curved head sheet is sixteen inches above the axis of the boiler. Develop the sheet and find its area and weight. Scale, 1½ in. = 1 ft.

VIII.

(a) There are two sheets in each course of shell plates. Tell what considerations determine the positions of the longitudinal joints and mark them distinctly on a circle to scale of question V.

(b) Make neat line sketch of axial section of flange of head sheet and shell in lower part of boiler, giving all dimensions on sketch.

IX.

(a) The screw stay bolts are spaced seven inches and are five inches long between sheets. Make neat sketch with all dimensions on it.

(b) Make neat sketches of longitudinal sections of both ends of common and stay tubes in sheets.

X.

(a) Compute the ratio of cross section of tubes to the grate surface. What are the usual values of this ratio?

(b) Compute the steam space. What is the usual proportion for this?

(c) Estimate with fair precision the tons of fresh water required for each boiler. One cubic foot of fresh water weighs 62.425 pounds.

DEPARTMENT OF STEAM ENGINEERING.
Annual Examination in Marine Engines.
Naval Cadets. First Class.
Engineer Division.

I.

Define clearly, concisely, and completely the following terms: (1) Total heat of evaporation; (2) latent heat of evaporation; (3) internal work; (4) external work; (5) specific heat at constant volume; (6) specific heat at constant pressure; (7) adiabatic expansion; (8) isothermal expansion; (9) intrinsic energy of a fluid; (10) the meaning of entropy.

II.

Explain the construction and operation of the simplest form of heat engine, and, calculating the work done during each step of its cycle of operations, find an expression for its efficiency. All formulæ used are to be deduced.

III.

Explain clearly the temperature-entropy diagram, taking into consideration the following points: The meaning of entropy, deduction of the formula for the entropy of steam and of water, the construction of the diagram, adiabatic and isothermal lines on the diagram, meaning of areas on the diagram, the forms assumed by the ordinary indicator cards when plotted on the diagram, and the representation of the dryness fraction.

IV.

(a) Using the entropy diagram furnished you, prove the following statements with reference to adiabatic expansion: (1) If steam is initially dry some is condensed during expansion. (2) If the initial state of the fluid is water, some of it is evaporated during expansion. (3) If water predominates in the initial state of a mixture of steam and water, steam is formed during the expansion, but if there is, initially, more steam than water in the mixture, some of the steam is condensed during the expansion.

(b) A quantity of dry air is suddenly compressed to one-half of its original volume, the compression being adiabatic. Find expressions for the work done during compression, the temperature after compression, and the final pressure.

V.

Name and explain seven causes of loss of efficiency in the steam engine considered as a thermo-dynamic machine.

VI.

Deduce an expression for the loss of efficiency, in a steam engine, due to incomplete expansion.

VII.

(a) Explain clearly the process of tempering in oil, and in water, and illustrate the latter process by tempering a cold chisel, and a screw tap.
(b) Make good sketches completely illustrating the steps in forging a large built-up crank shaft.

VIII.

Explain the principles of moulding in loam, green sand, and dry sand. The explanation is to be complete, concise, illustrated by neat side sketches, and is to contain a list of definitions of the principle terms used in the art.

IX.

Illustrate and explain the process of moulding, in loam, a screw propeller. The blades and hub are to be cast in one piece.

X.

Illustrate and explain the method of marking out a crank shaft for a triple-expansion engine. The method used is to be that explained to you in the machine shop of the department.

DEPARTMENT OF STEAM ENGINEERING.

Annual Examination. Designing Machinery.

First Class.

Engineer Division.

I.

Design and make a working sketch, two views, of a connecting rod for vertical engines of high speed, with the following data:

Triple expansion engine.	
Diameters of cylinders	42", 59", and 94"
Stroke	42"
Boiler pressure, absolute	175
1st receiver pressure, absolute	60
Diameter of crankpin	17"
Length of same	21.5"
Diameter of crosshead journals	9"
Length of same	9.75"
Width of cap, crankpin end	15"
Width of cap, crosshead end	8"
Length of connecting rod	84"
Distance between jaws of forked end	15"

The crosshead where the piston rod enters is 16 in. in line with the piston rod, and 13 in. wide.

Thickness of nut on crosshead end of piston rod, 7 in.

Connecting rod tapering from crosshead to crankpin end.

For white metal in the crankpin brasses:

Thickness of strips $= .04 \times D$. Breadth of strips $= .16D + .5"$.

Space between strips = thickness of strips.

Thickness of brass beyond white metal $= .1D$.

Thickness of crosshead brasses $= 1.5"$.

Distance from center line of bolts to extreme edge of caps to be equal to the diameter of the bolt multiplied by 0.8.

Formulæ:

$$D = \frac{\sqrt{R\,(1 + 4ar^2)}}{48.5}$$

$r = 10$ ..... Seaton.

For connecting rod bolts $f = 7000$, and for caps $f = 9000$.

The following are some of the principal points in the design:

Diameter of rod at crosshead end.

Diameter of bolts at each end.

Thickness and length of caps at both ends.

Dimensions of crankpin brasses—thickness, overhang, etc.

The section of the rod at the crankpin end, and of the jaws of the rod.

Sketch all essential parts of the rod, set screws, etc.

II.

Data: Vertical, inverted, triple-expansion, twin-screw engines. Diameters of cylinders 36, 52, and 80⅝ in., stroke 33 in., revolutions per minute 164, boiler pressure per gage 160 lbs., first receiver pressure, absolute, 60 lbs. (assumed), ratio of length of connecting rod to crank 4, distance between bearings 53 in., shaft has a 6-in. hole through it. $f = 9000$, K, for Unwin's formula for diameter, $= 4.3$, pressure on bearings not to exceed 190 lbs. per sq. in., ratio of length to diameter of journal is not to exceed 1.5, I. H. P. 4932. Cut-off .6 in H. P.

Find the diameter and length of main journals, applying the check for heating.

III.

Data: Three-cylinder, triple-expansion engines, cylinders 13.5, 21, and 31 in. in diameter, stroke 20 in., cut-off on H. P. cylinder 0.7 stroke, piston speed 800 ft. per minute, boiler pressure 160 lbs., vacuum 24 in.

(a) Find (1) the length and width of the steam port at the H. P. cylinder walls; (2) the diameter of the high-pressure piston valve, the length of the port in the liner being 1¾ in.

(b) Make a neat sketch of a piston valve chest liner, state the material it is made of, and explain how it is secured.

IV.

For the engine of problem III, with the following additional data, construct the valve in mid position with its chest and stem complete, giving all necessary data on the valve.

Data: Travel of H. P. valve 4 in., angle of lead at top 9°, at bottom 12°, exhaust closure at top and at bottom at 3 in. from end of stroke.

V.

Find the cooling surface, and the number, length, and diameter of the tubes for a single condenser for the engines of question III. The diameter of the tube sheet is limited to 4 ft. 3 in.

VI.

Show how the following elements of the design of a screw propeller are obtained: Pitch, diameter, and helicoidal area. Show how to lay down a developed blade of a modified Griffith screw, and how to obtain the width and the thickness of the blades at the different points.

DEPARTMENT OF STEAM ENGINEERING.

Semi-annual Examination. Principles of Mechanism.

Naval Cadets. Second Class.

Line Division.

I.

(a) Make neat sketches of the following: (1) Spur gear, (2) annular gear, (3) worm and wheel gear, (4) two bevel wheels in gear, (5) define by sketch: Pitch, point, and root of the teeth of a gear wheel.

(b) Find an expression for the resistance which will balance a given force applied to a knuckle joint.

II.

(a) A rack drives a lantern pinion. Make a large careful sketch of the combination and designate by letters and name the forms of the curves on the rack teeth above and below the pitch line.

(b) The relative angular velocities of the driving crank and the slotted bar in the slit bar motion are inversely proportional to the segments into which the perpendicular to the slotted bar drawn through the crank pin divides the line joining the centers of crank and bar. Prove.

III.

(a) In the four-bar motion the relative angular velocities of the cranks are inversely as the distances of their centers from the intersection of the link, or link produced, with the line of centers. Prove.

(b) Sketch and analyze the straight-line motion of Mr. Russell.

IV.

(a) Sketch a hand machine for cutting metals and explain the application of the four-bar motion and give an expression for the ratio of power to resistance.

(b) Sketch and explain the action of the feathering paddle wheel.

V.

(a) Sketch a cam device whereby a single cam plate may cause linear reciprocating motions in two directions at right angles to each other.

(b) Sketch an arrangement of open belts connecting two pulleys on axes at right angles to each other, showing the direction of motion and in what planes the belts go towards and from the pulleys.

VI.

(a) Fig. 1 shows the cone pulleys and back gear of a lathe. The numbers on the cones represent diameters, those on the gears, numbers of teeth. The shaft O makes 144 turns per minute.

Tabulate the various speeds at which the mandrel P may be run; first, without the back gear; second, with the back gear.

(b) In Fig. 2, a spindle S, with a right-handed thread of f to the inch, revolves in a fixed nut A and carries a worm of left-handed pitch engaging and driving the worm wheel B, B has 100 teeth whose pitch is 1 in. How many turns of the spindle S must be made to cause B to make one revolution?

VII.

Fig. 3 is a line sketch of an inverted, vertical engine. The engine has a stroke of 2 in. and the shaft is revolving at a uniform rate of 300 revolutions per minute. At the instant shown, find graphically on a full size scale drawing, also mathematically, the distance of the piston from the upper end of its stroke.

VIII.

In Fig. 1, the center lines of the shaft O and the mandrel P are 10 feet apart. Find the length of open belting necessary for use on the pulleys A and B.

IX.

(a) In Fig. 4, $AB=4''$, $OB=2''$, $BD=3''$, and C is the middle point of AB. The guides, AO and DO, are perpendicular to each other and

the point A is moving up with a velocity of 10 ft. per minute. C is a joint and B and D are constrained to move along OD.

Find graphically, on a full-scale drawing, the distance from D to that point in CD which is moving with the least velocity. Also find the velocity of this point, and calculate, from measured dimensions, the angle which its direction of motion makes with the direction of motion of the point D.

(b) In Fig. 6, $OB = 15''$, $BP' = 9''$, $DO = 7\frac{1}{2}''$. Find the lengths of z, y, and OA.

The figure represents a parallel motion. $DA = 5''$.

X.

In Fig. 5, A is an arm capable of moving in a vertical plane about an axis O. It carries the pulleys D, C, E, the dial plate F, and the pointer P. B is fixed, and from it runs an open belt to D. D and C are fast to the same shaft, which turns freely in the arm A. E and F are fast together, but turn freely on their axis, while the weighted pointer is free to move and is always vertical. C is connected with E by a crossed belt. F is graduated to 360° and is read from left to right. Suppose that the arm makes one-quarter turn with the hands of a watch, what will be the reading of the graduated plate, supposing that P now points to zero?

DEPARTMENT OF STEAM ENGINEERING.

Annual Examination.

Naval Cadets. Second Class.

Line Division.

Marine Boilers.

I.

(a) Name the different systems of forced draft and describe the systems generally adopted for modern war vessels.

(b) Define British thermal unit, Joule's equivalent, lap, lead, angular advance, clearance, cut-off, compression, release, relative volume, and specific volume.

II.

A boiler having an efficiency of 65% burns 1000 lbs. of coal per hour; temperature of feed, 100° F.; temperature of steam, 300° F.; composition of coal, .84 C., .056 H., .08 O., and .024 ash (neglect ash). Find the weight of steam generated per hour, and the quantity of air necessary per hour.

III.

(a) Sketch and describe the "Speedy" type of Thorneycroft boiler, showing the arrangement of tubes, admission of feed water, circulation of water, and direction of furnace gases.

(b) Name all of the attachments and orifices of a modern surface condenser and sketch and explain the method of packing and securing the tubes.

IV.

A cylinder full of steam discharges into a surface condenser. Area of cylinder, 706.86 sq. in. Stroke, 18 in. Pressure of steam, 10 lbs. absolute. Revolutions, 300 per minute. Temperature of steam, 193° F. Feed, 100° F. Injection water, 80° F. Discharge water, 100° F. Find the number of lbs. of cooling water required per hour.

V.

(a) Sketch and describe Marshall's valve gear.

(b) Show by sketches of indicator cards the effect of contracted steam ports, contracted exhaust ports, valve improperly set, angular advance too small, angular advance too great, leaky valve, leaky piston, and friction of the indicator.

VI.

U. S. S. Bancroft, main engines, high-pressure valve. Give the following data, viz.:

Steam lap 29/32 in., steam lead 3/8 in., exhaust lap 7/32 in., travel of valve 4 in. Construct the Zeuner valve diagram, find all other data, and tabulate the results.

VII.

(a) What are cast iron, cast steel, wrought iron, wrought steel, nickel steel, manganese bronze, aluminum bronze?

(b) Sketch a sectional view of a piston for a modern engine, naming the parts and showing how they are fitted and how the piston is secured to the rod.

VIII.

(a) What is priming? What causes it and how is it prevented?

(b) Sketch and describe the distiller used in U. S. Naval vessels.

IX.

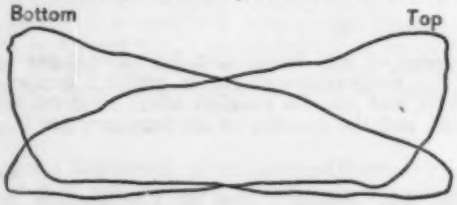
(a) A vessel at 120 tons displacement, engines developing 1875 I. H. P. and making 385 revolutions per minute, makes 24 knots speed per hour.

If the displacement be increased to 150 tons, how many I. H. P. and revolutions per minute will be necessary to drive her 15 knots per hour?

(b) Show how to construct a coal consumption curve and how to find the most economical speed.

X.

Find the indicated horsepower from the indicator card and data given below. The card is from the intermediate pressure cylinder of the *U. S. R. C. McCulloch.*



Data: Area of piston 1104.5 sq. in. Area of piston rod 19.6 sq. in. Stroke 30 in. Revolutions 154 per minute. Scale of indicator spring 40 lbs. = 1 in.

APPENDIX C.

SPECIMEN EXAMINATION PAPERS OF NAVAL CADETS BETWEEN THE YEARS 1882 AND 1889, WHEN ALL CADETS WERE GIVEN THE SAME COURSE FOR SIX YEARS AND COMMISSIONED AT THE END THEREOF INTO EITHER CORPS AS THE NUMBER OF VACANCIES DEMANDED, A SYSTEM THE COUNTERPART OF THE PRESENT ENGLISH SCHEME OF SO-CALLED AMALGAMATION.

1. Mechanics. Academy Course.
2. Steam Engineering. Academy Course.
3. Steam Engineering. Final Graduation.
4. Naval Architecture and Shipbuilding. Final Graduation.
5. Electricity. Academy Course.

ANALYTIC AND HYDRO-MECHANICS.

Second Class. Annual Examination.

Time allowed, 4 hours and 40 minutes.

I.

(a) A particle is placed inside a smooth sphere on the concave surface, and is acted upon by gravity and by a repulsive force which varies inversely as the square of the distance from the lowest point of the sphere. Find the position of equilibrium of the particle.

(b) Two persons pull a heavy weight by ropes inclined to the horizontal at angles of 60° and 30° with forces of 160 and 200 pounds respectively. the angle between the two vertical planes of the ropes is 30°. Find the single horizontal force that could have been applied to produce the same effect.

II.

(a) Derive formulæ for determining areas by Amsler's polar planimeter.

(b) Determine the position of the center of gravity of the volume included between the surfaces generated by revolving about the axis of X, the two parabolas $y^2 = mx$ and $y^2 = m(a - x)$.

III.

(a) If a vertical shaft is composed of two equal circular cylinders placed side by side, and rotates about the line of contact of the two cylinders, show that the moment of friction of the surface of contact with the horizontal plane is $\frac{32\mu a W}{9\pi}$.

(b) Through what chord of a circle must a body fall to acquire half the velocity acquired by falling through the diameter?

IV.

(a) Find the time of vibration of the compound pendulum to three terms.

(b) A thin plate oscillates about an axis passing through the circumference. Find the length of the equivalent simple pendulum (1) when

the axis touches the circle and is in its plane, (2) when it is at right angles to the plane of the circle.

V.

(a) If a pendulum be 45 inches long, how many vibrations will it gain in one day if the bob be screwed up one turn, the screw having 32 threads to the inch.

(b) A homogeneous sphere rolls directly down a rough inclined plane under the influence of gravity. Find the motion.

VI.

(a) A hemispherical cup is filled with water and placed with the base vertical. Find the pressure on the plane and curved surfaces.

(b) A circle is just immersed vertically in a fluid. Find on which chord drawn from the bottom of the circle the pressure is the greatest.

VII.

(a) Prove that the free surface of a rotating liquid is a paraboloid of revolution.

(b) A closed cylindrical vessel, height h and radius a, is just filled with liquid and rotates uniformly about its vertical axis. Find the pressure on the ends and on the curved surface.

VIII.

(a) A circular flood gate 4 ft. radius is hung on a horizontal axis 4 in. below the center of the circle. Find how high the water will rise before the pressure opens it.

(b) A vessel formed by the revolution of a semi-cubical parabola ($ay^2 = x^3$) about its axis, is filled with water till the radius of its surface is equal to the height above the vertex. Find the time of emptying the vessel through a small orifice at the vertex.

IX.

Derive a formula for determining g at any point of the earth's surface.

STRENGTH OF MATERIAL.

First Class. Semi-annual Examination.

Time allowed, 4 hours and 40 minutes.

I.

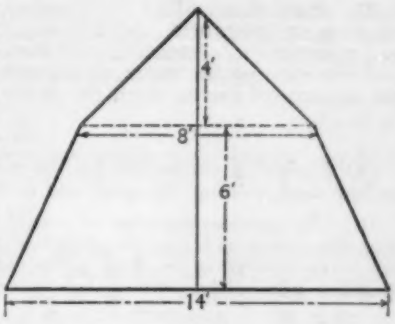
(a) The slopes of a simple triangular roof truss are 30° and 45° and the span is 10 feet, the rafters being 2½ feet apart along the wall and the weight of the roof 20 pounds per square foot. Find the thrust of the roof, and draw the reciprocal diagram.

(b) A load of 10 tons is suspended from a tripod, the legs being of equal length and making angles of 60° with the horizontal. Find the thrust on each leg.

II.

(a) The height of a mansard roof without bracing is 10 feet, and the span 14 feet. The height of the triangular upper portion is 4 feet and its span 8 feet. The load being 1000 pounds at the ridge, find the necessary load at each intermediate joint, and the thrust of the roof.

(b) The rise of a parabolic bow string girder is 15 feet and the span 120 feet; find the thrust when the platform is loaded with 2000 pounds per square foot run.



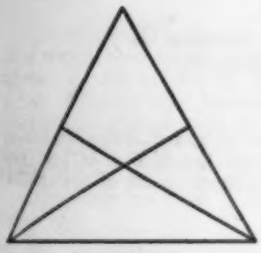
III.

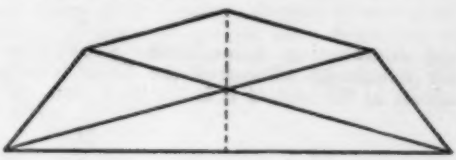
(a) A wooden beam of uniform cross section floats in water. Draw the curves of shearing force and bending moment when a weight is placed at the middle; also when there are two equal weights, one at each end.

(b) Find the internal pressure required to burst a thin hollow iron sphere 10 feet in diameter, ½ inch thick, the material having a tensile strength of 30,000 pounds per square inch.

IV.

Draw the reciprocal diagrams for the two frames shown under uniformly distributed loading.





V.

An iron rod, one inch in diameter, is found to stretch 1/15 of an inch under a load of 8 tons. Find the work stored up in the rod, and compare it with the work that would be stored up in a rod of the same length and material whose diameter for half its length is 2 inches and for the other half 1 inch, the load being the same.

VI.

(a) Derive the general formula for determining the curve of deflection of a beam subjected to flexure.

(b) In the case of a beam fixed at the ends and uniformly loaded, derive the expression for the bending moment at any point, and for the maximum deflection.

VII.

A beam fixed horizontally at one extremity and supported at the other, sustains a weight P at its middle point; find the equation of the curve of deflection and the points at which the moment of flexure is greatest and at which it is least.

VIII.

The upper flange of an *I* is 6 inches wide and 2 inches deep; the lower flange is 12 inches wide and 2 inches deep; and the web is 12 inches deep and 1 inch thick. Assuming each flange as concentrated at its center line, find the ratio of the stress of compression to that of tension. Find also the moment of inertia about the neutral axis.

IX.

(a) Derive an expression for the moment of resistance to torsion of a hollow shaft, r being the outer and r_2 the inner radius.

(b) The external diameter of a steel shaft designed to sustain a twisting moment of 500 inch tons, is 11 inches, and the greatest intensity of shearing force allowed is 3½ tons per square inch. Find the greatest internal diameter admissible.

X.

(a) In the case of a thick hollow cylinder subjected to internal pressure, derive an expression for the tangential stress at any point.

(b) The cylinder of an hydraulic accumulator has an internal diameter of 8 inches. Find the thickness of metal that would be required for an internal pressure of 70 pounds per square inch, the maximum tensile strength being limited to 2100 pounds per square inch.

STEAM ENGINEERING.

Second Class. Semi-annual Examination.

Time allowed, 4 hours and 40 minutes.

I.

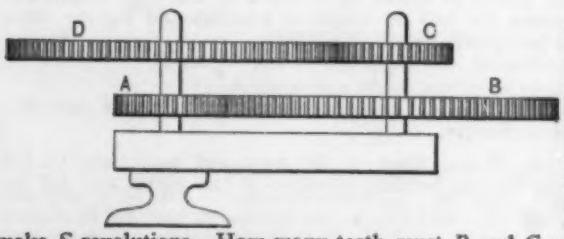
A direct-acting engine, stroke 4 feet, connecting rod 9 feet, revolutions per minute 50. Required the linear velocity of the piston in feet per minute at the instant it is one foot from its commencement of the stroke.

II.

(a) Sketch and prove Peaucellier's exact parallel motion.

(b) Sketch and describe the parallel motion of a grasshopper engine.

III.



(a) The teeth in this epicyclic train are all of the same form and pitch. The wheel A has a teeth and B is dead. D has d teeth. While the arm makes one revolution it is required that D shall make S revolutions. How many teeth must B and C each have? Results to be in terms of a, d, and S.

(b) Find the angle of the pitch surfaces of a bevel gear to connect two axes which intersect at an angle of 65°, so that the relative velocities shall be as 3 to 5.

IV.

The following change wheels are furnished with a lathe: One of 48 teeth, one of 36 teeth, and two of 24 teeth each. The leading screw has six threads to the inch. Only one wheel is to be used on the intermediate axis in each combination. Find what threads can be cut, and tabulate the wheels for each thread.

V.

Make a complete sketch of a double-ported slide valve and its seat, with Waddell's balancing arrangement.

VI.

Find (1) the total grate area; (2) heating surface; (3) the diameter of the smokepipes (there being two) for boilers to furnish steam for engines developing 8000 indicated horsepower. Twenty pounds of feed water are required per horsepower per hour; temperature of steam 338° F., and of feed 100° F., 20 pounds of coal are consumed per square foot of grate surface per hour; composition of coal is .88 C., .05 H., .020., and .05 ash; the efficiency of the boilers is 60%; the rate of transmission is 7500 thermal units per square foot of heating surface per hour.

VII.

(a) Sketch longitudinal and transverse sections of a cylindrical, horizontal, direct fire tubular boilers.

(b) Sketch four methods of stiffening a cylindrical furnace flue.

VIII.

(a) Stroke of a piston 48 inches (scale of crank circle 2 in. to the foot (valve circle full size). Given: Steam lap = 1 in., steam lead = ¼ in.; cut-off at 41½ in. from beginning of stroke; exhaust lead ¾ in. Find: Exhaust lap; maximum steam port opening; throws of eccentric; maximum exhaust port opening; distance of piston from beginning of stroke when steam is admitted; distance of piston from end of stroke when exhaust opens; and angular advance to the nearest minute.

(b) Define lap, lead, and angular advance.

STEAM ENGINEERING.

Second Class. Annual Examination.

Time allowed, 4 hours and 40 minutes.

I.

(a) Define the term "efficiency of a machine."

(b) What are the usual elements that constitute the total efficiency of a marine engine?

(c) Give the causes of loss in each.

(d) Explain fully what is meant by "loss from liquefaction in cylinders."

(e) State the different methods of reducing it and how it is accomplished by each.

II.

(a) Calculate the loss, per cent, by blowing off to maintain the density at $\frac{31/32}{32}$; density of feed, $\frac{1/4}{32}$; temperature of steam, 350°; of feed, 110°.

(b) Find the diameter of a double-acting circulating pump driven by the main engine; given, diameter of cylinder, 60 in.; stroke, 3 ft.; clearance, ½ piston displacement; revolutions, 40 per minute; temperatures, injection 60°, discharge 90°, hot well 110°, exhaust steam 225°. Exhaust opens 3 in. from end of stroke, exhaust pressure being 19 pounds.

III.

Find (1) total grate area, (2) heating surface, (3) diameters of funnel, for boilers to furnish steam for engines of 4000 indicated horsepower; 20 lbs. of feed water per horsepower per hour, temperature of steam, 338°; of feed, 100°; 25 lbs. of coal consumed per square foot of grate per hour; composition of coal, .88 C, .05 H., .020., .05 ash; efficiency of boiler is 60%; rate of transmission, 7500 thermal units per square foot of heating surface per hour.

IV.

(a) Sketch longitudinal and transverse section of a modern marine boiler.

(b) Find number and diameter of braces necessary to brace upper half of the head of a cylindrical boiler 10 feet in diameter, braces placed 1 foot apart between centers; pressure 100 lbs., absolute, per square inch; ultimate strength of material, 48,000 lbs. per square inch.

V.

(a) Describe fully the peculiarities and advantages claimed for the Griffith, Hirsch, and Mangin screw propellers.

(b) Explain fully the circumstances under which it is advisable to reduce the pitch of a propeller.

(c) Name and sketch two forms of radial valve gear.

(d) Sketch three methods of packing condenser tubes.

VI.

(a) State the various points of information that may be derived from an indicator card, and explain fully how each is determined.

(b) Explain what is meant by open or crossed rods in Stephenson's valve gear, and how does each affect the lead when shortening the cut-off by means of the link?

VII.

(a) Sketch a longitudinal section of a modern cylinder and piston.

(b) Why are independent cut-off valves seldom fitted to triple-expansion engines, and when not so fitted what arrangement is made for equalizing the horsepower when working at reduced powers.

VIII.

(a) Find the piston areas for a compound engine to develop 1200 indicated horsepower; initial pressure, 75 pounds per gauge; mean back pressure, 4 lbs.; final pressure, 10 lbs.; $p \propto \frac{1}{v}$; loss by drop and clearance to be neglected; 100 revolutions per minute; stroke, 3 feet.

(b) Utilizing both cylinders of the above engine, find the piston area of the high-pressure cylinder when it is converted into a triple-expansion engine with an initial pressure of 135 lbs. per gauge and final pressure as before. Find also the point of cut-off in the new high-pressure cylinder.

STEAM ENGINEERING.

Final Graduation.

Time allowed, 4 hours and 40 minutes.

I.

Give a general description of the engines and boilers of a vessel to which you have been attached, stating the name of the vessel, type of boiler, engine and screw propeller, the number and diameter of the cylinders, stroke of engine, and the indicated horsepower developed at full speed.

II.

Sketch a transverse and a longitudinal section of a cylindrical, return, fire-tubular boiler with two or more furnaces, showing method of bracing.

III.

Describe briefly the different ways of producing artificial or forced draft, stating the merits of and objections to each.

IV.

What care should be taken to preserve the life of a boiler on board ship (1) when in use; (2) when not in use?

V.

In case of the collapse of a crown sheet, what should be done? How may leaky boiler tubes be stopped when under steam? Describe briefly the fireman's duties in the fireroom when using natural draft. How do you determine when a fire needs cleaning, slicing, and coaling? In case of scanty fresh feed water, how supply the deficiency without using the auxiliary pump?

VI.

(a) Calculate the thickness of the shell of a cylindrical boiler, 15 feet in diameter, to withstand 135 lbs. per gage. Tensile strength of steel used, 64,000 lbs. per square inch. Factor of safety, 4½. Strength of seam is 80% of solid plate.

(b) Sketch and describe Joy's valve gear, stating its merits and objections.

VII.

Sketch a common slide valve to cut-off at ¾ stroke. Steam lead 10°. Exhaust closes at ⅞ stroke. State throw of eccentric. Width of steam port and maximum opening to steam, 2½ inches. Bridge, 1 inch. Exhaust port, 5 inches. Stroke of piston, 42 inches. Neglect the length of the connecting rod.

VIII.

(a) Find the pitch of the screw; given, revolutions per minute, 80; slip, 10%; speed of ship, 15 knots an hour, one knot equals 6086 feet.

(b) State the object of expanding pitch.

(c) Give comparative advantages and disadvantages of twin and single screws.

IX.

Find the indicated horsepower; given, gage pressure at cylinder, 60 lbs.; cut-off, ⅓ from beginning of stroke; clearance, 10% of stroke displacement; stroke, 45 inches; diameter of cylinder, 60 inches; vacuum, 26 inches; barometer, 30 inches; revolutions, 70 a minute; p varies as $\frac{1}{v}$. and $\log_e a = 2.3 \log_{10} a$.

60

X.

A vessel is capable of steaming 2500 knots at a mean speed of 12 knots an hour, the engines developing 3000 indicated horsepower. The consumption of coal per indicated horsepower is 2.6 pounds. How far can she go when developing 2000 indicated horsepower on a consumption of 2.3 pounds per indicated horsepower per hour?

NAVAL ARCHITECTURE AND IRON SHIPBUILDING.

Final Examination.

Time allowed, 4 hours and 40 minutes.

I.

(a) State the fundamental conditions of equilibriums of a body floating freely at rest in still water.

(b) Define buoyancy, displacement, tons per inch, coefficient of fineness.

(c) A vessel of 5000 tons, whose tons per inch is 30, passes from salt water to fresh water. What is her change in mean draft?

II.

(a) Define statical stability, metacenter.

(b) Deduce an expression for moment of statical stability at any angle of heel (Atwood's formula).

III.

Show how curves of statical stability are constructed, pointing out the important features of the curve, and stating the principal causes affecting each.

IV.

(a) State sources of resistance to rolling.

(b) Define rate of extinction, and show how it may be determined, and hence how the relative values of sources of resistance may be estimated.

V.

Describe with diagram the method of determining the effect of a squall striking a vessel (1) when upright and at rest, (2) when struck on maximum roll to windward.

VI.

(a) Define change of trim and moment to change trim one inch.

(b) Write an expression for the longitudinal metacentric height in terms of three dimensions.

(c) Given, that $L = 300'$; $B = 50$; draft forward $= 17'$; aft $= 19'$; $T = 40$; coefficient of fineness $= 50\%$; $b = .075$ (b is the constant in the expression for the longitudinal BM); center of buoyancy is 5 feet above the center of gravity; find (1) the moment to change trim one inch; (2) at what point can a weight of 40 tons be added in order that the draft forward may be not affected.

VII.

(a) What is the trachoidal wave theory?

(b) Show how the magnitude and direction of the resultant fluid pressure may be determined, and how it varies.

VIII.

(a) Define virtual upright and virtual righting moment.

(b) Discuss the behavior among waves of a vessel with all sail set.

IX.

Given, $T = 554 \times \sqrt{\frac{K^2}{m}}$ $\quad BM = \frac{1}{v}\theta = \frac{aT^3}{T_1^2 - T^2}$

discuss the behavior of a vessel of the American monitor type among waves. (Monitor has great beam as compared to the volume of displacement and overhanging armor belt.)

X.

Discuss clearly the behavior of a single screw (right-handed) steamer under the action of the rudder.

XI.

Sketch and describe the keel and keel connections of an armor-clad war vessel, stating which parts are continuous.

XII.

Describe, with sketch, the stem of a ram, showing clearly its connection with the keel.

XIII.

(a) Describe the essential features of the bracket system of framing.

(b) What difference is made in fitting a water-tight frame.

XIV.

(a) Describe the common method of applying the outside plating of war vessels.

(b) State clearly how plates are fitted and secured, and how the butts are shifted.

XV.

Define stringers, tie plates, shear strakes, liners, and stealers, and state the exact functions of each.

XVI.

(a) Sketch and describe the different kinds of beams.

(b) How are beams formed?

(c) How are beams bent?

XVII.

Describe the method of fitting bulk heads in war vessels.

XVIII.

(a) What is a bending slab?

(b) What is a scrive board?

(c) Describe the manner of bending angle irons.

ELECTRICITY.

Second Class. Annual Examination.

Time allowed, 4 hours and 40 minutes.

I.

Define specific inductive capacity, electro-static capacity of a conductor, density of a charge, numerical value of the difference of potential between two points, ampere, volt, ohm, electro-chemical equivalent, watt and joule.

II.

(a) Three balls, *A*, *B*, and *C*, are of radii 6, 3, and 4 cm., respectively. *A* is charged to potential 8, is then touched to *B*, and then to *C*. The insulated balls are placed in a straight line so that *B* is 15 cm. from each of the others. What is the resultant force of the charges of *A* and *C* on *B*?

(b) What is the potential at a point *D*, 40 cm. from both *A* and *C*?

III.

(a) Describe exactly how to use the Kew magnetometer to determine the horizontal intensity of the earth's magnetism.

(b) If *H* is known, how may the vertical component and the total intensity be found?

(c) Why is *H* experimentally determined rather than *I* or *V*?

IV.

A dipping needle makes 122 oscillations in a certain interval of time when oscillating in the plane of the magnetic meridian. Find the angle of dip.

V.

(a) When the deflected needle of a sine galvanometer is in equilibrium what are the forces acting upon it?

(b) What are the expressions for their moments?

(c) A steel bar, 25 cm. long, .8 cm. radium, coefficient of magnetic induction 14, is in a uniform field of strength 45. What will be the magnetic moment and intensity of magnetization of the bar?

VI.

(a) Describe the LeClanchè cell and its reaction.

(b) For what purpose may it be used?

(c) A tangent galvanometer and a voltmeter are placed in circuit with a battery for 4 hours and 40 minutes. The voltmeter contains silver nitrate, and 0.3332 grammes of silver are deposited, and the mean deflection of the galvanometer, corrected for torsion, is 44° 59′ 42″. Find the constant of the galvanometer. The electro-chemical equivalent of *H* is .000010352 and the atomic weight of silver is 108.

VII.

The interpolar portion of a voltaic circuit consists of three separate wires in multiple arc, their resistances being 30, 50, and 70 ohms. If the electro-motive force of the battery is 5 volts and the internal resistance is 6 ohms, find the current in the battery and through the wire of greatest resistance.

VIII.

(a) Given, a shunt wound dynamo, E. M. F. 96 volts, resistance of field magnets 6 ohms, of armature 0.3 ohm, how many lamps in multiple arc, each having a resistance of 100 ohms and requiring a current of .8 ampere, will the machine work?

(b) If 8 horsepower are applied to turning the armature of the dynamo, what are the gross and net efficiencies?

(c) Calculate the work in watts lost in the armature and in the field coils.

IX.

A cell placed in circuit with a reflecting galvanometer and a resistance of 1430 ohms gave a deflection of 40 divisions, and when a resistance of 735 ohms was added the deflection decreased to 25 divisions. A standard cell, E. M. F. 1.45 volts, gave with the same galvanometer and 960 ohms resistance, a deflection of 40 divisions. Find the E. M. F. of the first cell.

X.

The needle of a tangent galvanometer of 50 turns of wire of mean radius 16 cm. and resistance of 1.5 ohms, makes 20 vibrations a minute in the earth's field, where $H = .18$. How many vibrations will it make in a minute if the coils are placed at right angles to the magnetic meridian and a current from 16 Grove cells arranged to give the greatest effect is sent through them so as to increase the earth's field. Resistance of each cell .4 ohm, and E. M. F. 2 volts.

XI.

A room is lighted by 25 Edison lamps (in multiple arc) each requiring .8 ampere. If a margin of 25% excess of current be allowed, find the diameter of a lead safety plug which should be inserted in the supply wire. Specific resistance of lead is 19.85 microhms, melting point 335° C., loss of heat by radiation and convection per square centimeter of surface is .001 joules per second for each degree difference of temperature (air at 22° C.)? Are the length and the specific heat of the safety plug of importance? Why?

XII.

(a) A Farmer's machine gives an E. M. F. of 18 volts, and has a resistance of 5 ohms including leading wires. What is the greatest number of fuzes and what will be their arrangement that it will fire simultaneously? Each fuze requires a current of .6 ampere and has a resistance of .75 ohm.

(b) Make sketches showing the difference between series and shunt wound dynamos, also sketches of a differential wound motor.

(c) If E be the E. M. F. of the dynamo and e that of the motor, prove that the efficiency of the motor is $\frac{e}{E}$.

XIII.

(a) A vertical coil, radius 7 cm., made of iron, resistance being .0011 ohm per cm., revolves from north to east at the rate of 100 revolutions per second. Show the direction of the current and determine its strength in amperes when the coil is at an angle of 60° with the meridian. $H = .2$.

(b) Give some method of comparing the capacities of two condensers.

XIV.

(a) Give some method of measuring battery resistance.

(b) A fault was detected in a cable 60 miles long, of ordinary conductivity resistance 540 ohms. It was looped with a perfect cable of 730 ohms resistance, the two making the branches *DC* and *BC* of a Wheatstone bridge, *ABCD*, the galvanometer being in *BD*. *AB* and *AD* were made 100 ohms each, and when 420 ohms were added to *DC* balance was obtained. Find distance of fault from testing station, and derive the formula used.

APPENDIX D.

SPECIMEN EXAMINATION PAPERS IN ENGINEERING OF CADET ENGINEERS AND CADET MIDSHIPMEN PRIOR TO THE AMALGAMATION OF THE TWO BRANCHES INTO NAVAL CADETS IN 1882.

1. Strength of Material. Academy Course.
2. Marine Engines. Academy Course.
3. Designing Machinery. Academy Course.
4. Marine Engines. Academy Course for Cadet Midshipmen.

STRENGTH OF MATERIALS.

Annual Examination.

Cadet Engineers of First Class.

Time allowed, 4 hours.

I.

Having given the angles which three conjugate stresses make with one another, determine the obliquities of those stresses, and the angles between the normals to their planes of action.

II.

Derive the general differential equations for the internal equilibrium of a body.

III.

Find the stresses on the parts of a half lattice guider, uniformly loaded at every point.

IV.

In an isotropic substance, find the coefficients of transverse elasticity and of elasticity of volume in terms of the coefficients of direct and lateral elasticity; the coefficients of transverse and of cubic compressibility in terms of the coefficients of direct and lateral pliabilities; the coefficients of direct and lateral elasticities in terms of the coefficients of direct and lateral pliabilities; and the coefficients of direct and lateral pliabilities in terms of the coefficients of direct and lateral elasticities.

V.

Find the pressure on the right-hand support, the abscissa of the point of inflection, and that of the point of greatest deflection in a given uniform beam, fixed at the left-hand end, supported at the right-hand end, and loaded with the weight *P* at the middle point.

VI.

Find the proper diameter of a cylindrical shaft in terms of the moment of torsion, and of the working shearing stress of the materials of the shaft.

VII.

Deduce the differential equations between the dynamic head in a fluid and the motion in the direction of three rectangular axes, and prove that for steady motion $\frac{v^2}{2g} + h =$ a constant.

MARINE ENGINES.
Annual Examination.
Cadet Engineers of First Class.
Time allowed, 5 hours.

I.

Required the I. H. P. of a double-acting engine having a sector cylinder, the coal per I. H. P. per hour and the efficiency of the steam. Extreme radius of piston, 54 in.; breadth of piston, 60 in.; diameter of rock shaft, 12 in.; angle swept by piston, 90°; double strokes per minute, 50; initial pressure of steam, 40 lbs. per gage; cut-off, 60°; vacuum in cylinder, 24; p varies as $v^{-\frac{17}{16}}$; $p = \frac{15\frac{1}{16}p}{r}$.

II.

Required the weight in tons (if applied at the periphery) of a fly wheel of 37½ ft. diameter for a pumping engine whose cylinder is 100 in. diameter by 8 ft. 3 in. stroke. Revolutions per minute, 25; coefficient of fluctuation $= \frac{1}{35}\frac{DE}{fPd} = 0.2$; initial pressure of steam, 50 lbs. per gage; back pressure 4 lbs. per sq. in. absolute; cut-off, ⅛; p varies as $\frac{1}{v}$; $\log_e 8 = 2.079$.

III.

Required the top and bottom breadths and depths of a head race whose cross section is a semi-hexagon, to supply 12,000 cubic feet of water per minute. Length of race, 500 ft.; loss of head from friction in race, 5 ft.; $f = 0.008$; $m = \left(\frac{FQ^2}{2yn^2l}\right)^{\frac{1}{5}}$.

IV.

Required the H. P. per lb. of fuel of a blowing engine to supply 225 cubic feet (18 lbs.) of air at 52° F. Grate surface 378 sq. ft.; coal per sq. ft. of grate 15 lbs. per hour; temperature of air leaving blower, 100°; gases in chimney, 480°; the engine to give a pressure equal to a head of 100 feet of gas; net work equals 60 per cent of gross work of engine. Required also the temperature of the furnace when the coal is composed of C, 0.87; O, 0.04; H, 0.05. Mean specific heat of products of combustion is 0.238; density of air at 32° F. and one atmosphere pressure is 0.0807.

V.

Required the I. H. P., the revolutions per minute of a double-acting engine, and the speed of the vessel in knots per hour (a knot is 6086 ft.); piston area, 2664 sq. in.; stroke, 10 ft.; back pressure, 4 lbs. absolute; clearance not considered; diameter of rolling circle of wheels, 19 ft.; resistance of vessel, 15,000 ft. lbs.; friction of unloaded engine, 1.5 lbs. per sq. in. at piston; friction of the load is 15% of the useful load; coal per hour, 2040 lbs.; cut-off at ¼ stroke; p varies as $v-1$; $Ph = \frac{(15\frac{1}{2}p)}{r}$ $\log_e 4 = 1.386$.

VI.

(a) Deduce the expression for the leverage of friction for a collar thrust.

(b) Required the H. P. necessary to turn a shaft in a collar thrust bearing, the thrust being 50,000 lbs.; revolutions per minute, 70; radii of collars, 13 in. and 10 in.; coefficient of friction, 0.05.

VII.

Sketch a Bourdon pressure gage and demonstrate its action.

VIII.

Required the pounds of water evaporated from 1 sq. ft. of tube surface, and also from 1 sq. ft. of crown sheet, considering the rate of conduction to be as the square of the difference of temperatures; $a = 180$; temperature of feed water, 100°; of furnace, 2400°; of gases in tubes, 800°; pressure of steam, 60 lbs. per gage.

IX.

(a) Sketch and describe Joule's proposed air engine.

(b) Construct cards from a pump and cylinder using the same scales for each, strokes being the same, and the working temperatures being 70° and 600°.

X.

Required the pounds of water evaporated per pound of coal from data given on the indicator card on sheet "B."

Available heat of one pound of coal is 6,000,000 ft. lbs.

$$r = 1 \div \left\{ \sqrt{\left(\frac{A - \log p}{U} + \frac{B^2}{4C^2} \right)} - \frac{B}{2C} \right.$$

For water $\begin{cases} A = 8.2591; \ \log B = 3.43642; \ \log C = 5.59873 \\ \frac{B}{2c} = 0.003441; \ \frac{B^2}{4C^2} = 0.00001184. \end{cases}$

DESIGNING MACHINERY.

Annual Examination.

Cadet Engineers of the First Class.

Time allowed, 5 hours.

I.

(a) Determine by the method of augmented surface the I. H. P. neces-

sary to drive a vessel of the following dimensions at a speed of 12 knots an hour; length on L. W. L., 325; mean immersed girth, 60 ft.; sines of angles of greatest obliquity of water lines, keel 0, 1st 0.1, 2d 0.2, 3d 0.3, 4th 0.4; coefficient of propulsion, 20,000.

(b) Also determine the I. H. P. for the same vessel by Fronde's law of comparison. Dimensions of model, 1/25 of those of the vessel; resistance of model at a speed of 200 feet per minute is one pound (consider knot as 6000); power used in propulsion is 40% of H. P.

II.

Determine the diameter, inside length (between heads), and thickness of cylinders for a pair of non-condensing engines to develop 350 H. P. Revolutions per minute, 80; stroke, 3 ft.; boiler pressure, 63 lbs. per gage; steam cut-off at 10 in.; back pressure, 2 lbs. above atmosphere; clearance, 12.5% of stroke displacement; exhaust closes 9 in. from end of stroke; p varies as $\frac{1}{v}$.

III.

Pair of simple condensing engines; diameter of cylinder, 50 in.; stroke of piston, 42 in.; boiler pressure per gage, 37 lbs.; vacuum, 24 in.; revolutions per minute, 55; cut-off at half stroke; neglect clearance; p varies as $\frac{1}{v}$; required diameter of single piston rod and diameter and length of crank pin. Deduce the formula for length of crank pin and show that the resistance to heating is independent of the diameter. Wrought iron, $f =$ 36,000 for direct crushing; crank pins ultimate strength $d = .04554 \sqrt{APl}$; for 1/100 deflection $d = 0707 \sqrt{APl^2}$; work per sq. in. of pin, 50,000 units; coefficient of friction, .05.

IV.

Make torsion diagram for line shaft for question III and determine diameter of shaft, using data from diagram. Cranks being placed at right angles; scale of pressure 32 lbs. equals one inch; and $f = 54.000$ for wrought iron.

V.

Design a three-parted slide valve for engine of question III (by a Zeuner diagram) to cut off at ¾ stroke; steam valve opens when piston is 1 in. from end of stroke; exhaust closes 8 in. from end of stroke. Required in inches, opening of steam port; steam lap, steam lead, exhaust lap, and exhaust lead; mark dimensions on lines measured. Show angle between eccentric and crank, and give distance in inches of the piston from end of stroke when exhaust valve opens; give scale for eccentric throw; scale for crank circle is ⅛.

VI.

Design a Meyer expansion valve (by Zeuner diagram); throw of eccentric, 6 in.; lap of steam valve, 2 in.; angular advance of main eccentric, 30°; limits of cut-off, ⅛ stroke and point of cut-off of main valve; throw of cut-off eccentric same as main eccentric. Give approximate angular advance of cut-off eccentric, and mark its relative position, that of the main eccentric, and of the crank; maximum distance the centers of cut-off and main valves will be apart; distance the cut-off blocks will be apart when cutting off at ⅛ and at ½ stroke; and the width of the cut-off blocks.

VII.

Compound condensing marine engine of 800 I. H. P., using 20 lbs. of steam per I. H. P. at a pressure of 80 lbs. per gage. Design boilers to furnish steam for this engine, and to burn anthracite coal by natural draft.

Required number, diameter, and length by boilers; thickness of shell and kind of riveting; number, size, and arrangement of furnaces; total grate surface, heating surface, and colorimeter through tubes and at uptake; diameter of tubes and number for each boiler, and total steam space.

VIII.

(a) From diagram (sheet B) calculate requisite condensing surface and diameter of a single-acting feed pump of same stroke as engine.

(b) Sketch and describe Sewell's, Allen's, and Stimer's methods of packing condenser tubes.

IX.

Required, the length, depth, and number of buckets for a radial paddle wheel; also the greatest dip, to drive a vessel 11.15 knots per hour, the resistance at that speed being 20,000 lbs., slip of outer edge of paddles 30% of speed of vessel, and the wheels to make 18 revolutions per minute.

DESIGNING MACHINERY.

Annual Examination.

Cadet Engineers of Second Class.

Time allowed, 4 hours.

I.

The efficiency of a given engine is 0.1 and of the boiler 0.8. The composition of the coal is C 90, H 6, and O 4. How much coal must be burned per hour to develop 400 H. P.?

II.

Find from indicator card and data on sheet A, considering clearance and recompression, the required weight of feed water per hour. Density of feed water $\frac{1}{32}$, density of water in boiler $\frac{15}{32}$. The weight of steam passing through the jacket is 1/10 that used in the cylinder.

III.

From the indicator card and data on sheet B find the H. P. This engine has a friction dynamometer attached, with a weight of 3050 lbs. on a balanced lever ten feet long. Find what per cent of the H. P. is wasted in friction.

IV.

An engine uses dry saturated steam of 63 lbs. per gage initial pressure, expanding it in a steam-jacketed cylinder, without clearance to a pressure —3 lbs. per gage and exhausting it against a back pressure of —11 lbs. per gage. Piston speed, 600 feet per minute; H. P., 200. Find weight of steam used in the cylinder per hour per H. P. and the area of the piston.

V.

A ship makes 10 knots per hour, burning 16 tons of coal per day, and carries 138.24 tons of coal in her bunkers. What distance can she make good against a current of 8 knots an hour?

VI.

(a) Sketch a three-ported slide valve without lap or lead in its proper position when the piston is at half stroke.

(b) Sketch a perfect indicator diagram (giving scale) from a condensing engine using steam of 60 lbs. gage pressure and cutting off at 1/6 stroke. Change it by dotted lines to a card from a non-condensing engine using same steam and expansion; also show, by broken and dotted lines, excessive steam lead and late exhaust. Show atmospheric and zero lines.

VII.

A pair of bevel wheels, A and B, with axes at right angles, have an angular velocity ratio of $\frac{A}{B} = 5/3$. A has twelve teeth, and the diameter of the base of its pitch cone is 4.5 inches. Construct full size at least 1½ teeth of the pattern for the teeth of the larger wheel, using the odontograph, and show section of the wheel. Lay off all dimensions to the nearest 1/16 of an inch.

VIII.

A lathe having a countershaft and back gear is driven by a line of shafting making 100 revolutions a minute. There are to be 12 changes of speed of mandrel, increasing from 4 per minute by a common ratio of 1.5. The sum of the diameters of all opposite pulleys is to be 20 in. Find and arrange size of all pulleys and train for back gear.

IX.

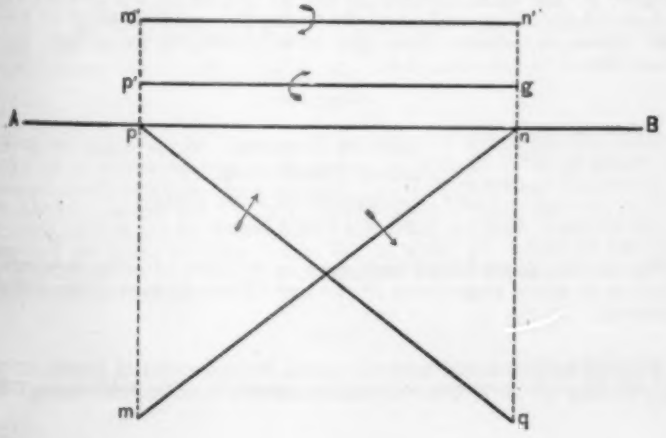
A clock having hour, minute, and second hands has 24 coils on barrel, and runs for one day. The pendulum makes 2½ beats per second. The distance between the axis of the barrel and that of the hour and minute hands is 6.5 in., and the diametral pitch of wheels on those axes is ⅛ in. No wheel to exceed 96 and no pinion to have less than 8 leaves. Give the entire notation.

X.

A cam revolves once a minute, and gives motion to a rod whose line of motion passes through center of motion of cam. Travel of rod 2 in. The rod rises for 25 seconds with a uniform motion, remains at rest for 20 seconds, and descends during the remainder of the revolution with an uniformly accelerated motion. Lay down the cam full size on a base circle of 3 in.

XI.

The two shafts MN and PQ, connected by a flat endless belt, revolve



as shown, with angular velocity ratio $\frac{MN}{PQ} = 4/5$, and the pulley on MN is 20 in. in diameter. Give the horizontal and vertical projections of the pulleys and belt, giving dimensions.

XII.

Construct, full size, the necessary mechanism for producing a quick return in a sliding piece having a path of 4 in., with a coefficient of friction of .57735. The ratio of periods of $\frac{\text{advance}}{\text{return}} = 7/5$.

XIII.

Construct the necessary mechanism for showing the motions about the sun of two planets, A and B, whose periods are 244 and 100 respectively; the planets to have no absolute motion about their own axes.

XIV.

Eccentrics of 4 in. throw and link work as shown in accompanying figure. How far will the point c be from the present position when the center of the eccentric a has arrived at a'? Neglect angularity of rods and consider points c, i, and e to move in straight paths, as shown by red lines.

XV.

The cross head of an engine of 4 ft. stroke is to be guided by an exact parallel motion, whose fixed centers are respectively 2 ft. and 3 ft. from the center line of cylinder. Construct the mechanism to scale, showing by full lines the position at end of stroke, and by broken lines at half stroke.

XVI.

A rope ab takes 1½ turns around a pulley A, one end being made fast and the other carrying a weight W; it is found that with ½ turn of the rope around the pulley a weight of 1 lb. at a will support 2 lbs. at b, a rope c being unwound from drum B, and its tension is not to exceed 2100 lbs.; find weight W.

XVII.

A lathe has 4 threads per inch on a right-handed leading screw; find the sizes of the least number of change wheels to cut threads (right-handed) of 5, 6, 8, 9, and 10 to the inch; the smallest wheel to have 20 teeth. Show in tabular form the arrangement of the wheels for the various cuts.

MARINE ENGINES.

Annual Examination.

Cadet Midshipmen of First Class.

Time allowed, 5 hours.

(NOTE.—This paper shows that, even in the days of cadet engineers, the education in steam engineering of the line-officers-to-be was not altogether neglected.)

I.

Given, an engine whose piston is 40 in. in diameter and whose stroke is 4 ft.; cutting off at ¾ from commencement of stroke; clearance, 1/10 of

piston displacement per stroke; steam pressure, 30 lbs. per sq. in. per gauge; vacuum, 26 in. (barometer at 30); revolutions, 50 per minute; relative volume of steam and water at initial pressure, 610: 1; log_e 1.27 = .239; log_e 1.28 = .2469; log_e 1.29 = .2546; log_e 1.30 = .2624. Required the mean effective pressure and the number of pounds of water evaporated per pound of coal. Coal consumed per hour is 1831.25 lbs., and weight of a cubic foot of fresh water is 62.5 lbs.

II.

Sketch and describe the Wabash or Meyer valve and explain the principal peculiarities of the Waddell valve. What is the advantage of the double-ported slide over the single ported?

III.

Water enters the boiler at a density of 7/8 and is maintained at 2; temperature of the water entering is the same as the temperature of the condenser, 103° F.; vacuum, 28 in.; compare the economic performance of the engine under these circumstances with the same engine, densities remaining the same, but the water in the condenser (feed water) having a temperature of 135°, and corresponding pressure of 2.5 lbs. per sq. in., the mean pressure of steam being 25.46 lbs. per sq. in., and the corresponding temperature 241° F.

IV.

Given, the thrust T of a screw propeller, to deduce the formula for the diameter of the shaft to resist torsion due to T, and solve the following: Example: Diameter of propeller, 16 ft.; pitch, 20 ft.; I. H. P., 1000; speed of ship, 12 knots (1 knot = 6082 ft.); slip, 15 per cent speed of propeller; coefficient of metal per sq. in. of cross section for a leverage of 1 ft., 120.

V.

Deduce the formula for the thickness of cylindrical boiler shells, and find the thickness for a cylindrical boiler, 8 ft. in diameter, for a working pressure of 80 lbs. per sq. in. per gage; seams double diveted; value of metal, 54,000 lbs. per sq. in. of cross section; factor of safety, 6.

VI.

How much water would be evaporated from and at 212° F. by the heat available for generating steam by the combustion of 10 lbs. of fuel, composed of C 90, O 5, H 3, and ash 4; burned with 25 lbs. of air per pound of fuel. Air enters at 60° F. and products of combustion escape at 600° F. Specific heats: CO_2 is .217; H_2O is .475; N is .245, and O is .218.

VII.

Given, an engine 42 in. diameter of piston, and stroke 3½ ft.; clearance, 3 per cent of piston displacement per stroke; cut-off, 4/10 of stroke from commencement; mean absolute pressure found from card 40 lbs. per sq. in.; back pressure, 4 lbs. per sq. in.; relative volume of steam and water at initial pressure is 513 to 1; weight of cubic foot of fresh water is 62.5 lbs. Supposing the boiler to evaporate 10 lbs. of water per pound of coal, what is the efficiency of the whole arrangement expressed in pounds of coal per horsepower per hour.

VIII.

Find area of piston in square inches for an engine which will exert 1300 H. P. under the following conditions: Initial pressure (p_1), 55 lbs.; final

pressure (p_2), 37 lbs.; back pressure (p_3), 4 lbs.; effective work per pound of steam, 72,182 foot pounds per hour; length of stroke, 3 ft.; revolutions, 75 per minute; volume of 1 lb. of steam at 37 lbs. pressure is 11.07 cu. ft.

APPENDIX E.

GENERAL STATEMENT OF REQUIREMENTS FOR GRADUATION OF ENGINEER CADETS OF THE ENGLISH NAVY FROM THE ENGINEERING SCHOOL AT KEYHAM, PRIOR TO THE INAUGURATION OF THE PRESENT SCHEME OF AMALGAMATION.

SUBJECTS TAUGHT.

1. Mechanics.
2. Mechanism and Applied Mechanics.
3. Applied Mechanics and Strength of Material.
4. Physics.
5. Electricity.
6. Mechanical Drawing.
7. Workshop Appliances and Practice.
8. General Engineering Lectures.
9. Metallurgy.
10. Design of Machinery Material.

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1. MECHANICS.

Practical Mensuration.—Regular and irregular areas by various methods. Prisms and cylinders. Solids of revolution, using the theorems of Guldinus. Irregular solids, by displacement, and by weighing in water, or some other liquid.

Specific Gravity.—Definition and determination for solids and liquids.

Hydrostatics.—Definition and meaning of hydrostatic pressure. Expression for pressure at any depth in a heavy liquid. Comparison of specific gravities of liquids by balancing columns in a U or V tube. Principle of Archimedes. Simple cases of flotation. Hydrometers, barometers. Boyle's law. Definition of fluid, liquid, gas. Resultant pressure. Expression for resultant pressure on any plane surface submerged in a liquid. Tension of a cylindrical or spherical vessel due to pressure of contained fluid. The Bourdon gage. Resultant vertical pressure on any surface. Center of pressure on a plane area. Applications to practical cases. Stability of flotation. Metacenter. Determination of metacentric height by heeling a ship. Easy problems on stability of flotation of right prism and cylinders.

Hydraulics.—Head. Velocity due to a given head. Torricelli's theorem. Coefficients of contraction; velocity; resistance. Flow through pipes. Continuity of flow. Critical velocity. Interdependence of hydrostatic pressure and velocity. Bernoulli's theorem. Discontinuous flow. Cavitation. Siphons. Surface friction. Laws. Loss of head by friction. Friction in pipes. Hydraulic gradient. Flow along an open channel. Summation of losses of head. Flow of gases under small differences of pressure. Application of principles to machines.

Statics.—Specification of a force. Representation of forces by straight lines. Meaning of component, resultant, and equilibrant. Enunciation and experimental verification of the parallelogram of forces. Center of gravity and its experimental determination. Geometrical methods of finding the center of gravity of a triangle and of a plane quadrilateral. The triangle and polygon of forces. Graphical construction in simple cases of

pin-joint frames (cranes, roofs, girders) where polygon of forces only is required. Proof that the moment of a resultant is equal to the sum of the moments of its components. Couples. Reduction of any system of forces to a single force and a couple. Representation and composition of couples. Center of gravity. Determination of the distance of the center of gravity of a body from any plane in terms of the distances of the centers of gravity of its component parts. Stability and instability of the statical equilibrium of heavy bodies. Friction; limiting friction. Angle of rest. Elementary machines. Mechanical advantage. Lever. Wheel and axle, pulley. Inclined plane. Wedge. Screw. The same machine with friction.

Dynamics.—Meaning of the terms work and energy, potential energy and kinetic energy, with illustrations of the conservation of energy.

Kinematics.—Motion of a point or particle. Distinction between speed and velocity. Parallelogram of displacements and of velocities. Relative velocity. Acceleration. The laws of uniformly accelerated rectilinear motion. Definition of average velocity during an interval. Its value when the motion is rectilinear and uniformly accelerated. Falling bodies and projectiles considered as uniformly accelerated particles. Direct experimental determination of g. Angular velocity. The kinematics of uniformly accelerated rotation about a fixed axle.

Kinetics.—Force. Mass. Laws of motion. Momentum. Conservation of momentum. Impact, direct and oblique. Coefficient of restitution. Newton's experiments. Applications to pressure produced by jets, coiling of chains, and kinetic theory of gases. Work and energy. Conservation of energy. Units of measure. Dimensions of physical quantities. Absolute and gravitation units. The C. G. S. system. Uniform motion in a circle. Centripetal force. Conical pendulum. Simple harmonic motion. Rectilinear elastic oscillations. Simple pendulum.

Rigid Dynamics.—Definitions. Rigid body. Moment of inertia. Radius of gyration. Angular momentum. Dynamical measure of torque and couple. Work done by a couple. Kinetic energy of rotation. Elementary theorems concerning moments of inertia. Properties of principal axes. Equimomental systems. Angular oscillations. Rigid pendulum. Simple equivalent pendulum. Conservation of angular momentum; simple illustrations. Ballistic pendulum. Rotation combined with translation. Examples of bodies rolling along a straight line. Centripetal and centrifugal forces. Centrifugal couples. Balance of rotating machinery. The practical balancing of engines. Center of percussion. Composition of angular velocities and of angular momenta.

Dynamics of Wave Motion and Radiation.—Transmission of vibratory motion through a medium. Mechanical examples. Transmission of waves along cords over water, and through air as sound. Connection between vibration frequency (or period). Velocity of transmission and wave length. Meaning of "wave front." Mechanical explanation of reflection and refraction of waves. Demonstration by means of water waves and light waves. Explanation of focal properties of lenses. Absorption of wave motion by synchronous oscillators. Mechanical illustrations. Resonance. Dangers to ships, structures, and machinery resulting from mechanical synchronism. Application of the theory of synchronism to explain the dark lines in the solar spectrum. Outlines of spectrum analysis. Connection between velocity of propagation and the physical constants of the medium.

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2. MECHANISM AND APPLIED MECHANICS.

Descriptive Mechanism and Elementary Theory.—Definition of a machine and a mechanism. Sliding, turning, and screw pairs. Velocity ratio, toothed gearing. Bevel-wheel gearing. Belts and pulleys. Guide pulleys. Quick-return and reversing motions. Screw cutting. Feed mechanism in

drilling machines. Differential motions. Epicyclic train of wheels, with applications. Link work. Instantaneous center. Slot-bar motion. Mechanism of direct-acting engine. Speed of piston. Angular motion of connecting rod and velocities of rubbing of gudgeon pin and crank pin brasses. Curves of velocity ratio and position of piston and slide valve. Oscillating engine. Whitworth shaping machine. Oldham's coupling. Rapson's slide. Toggle joint. Hooke's joint. Bell crank levers. Parallel motions of Watt, Peaucellier, and others. Pantograph. Cams. Teeth of wheels.

Applied Mechanics.—Graphical construction of resultant of any system of forces in one plane. Funicular polygon. Suspension chains. Centers of gravity. Graphical representation of moments. Loaded beams. Diagrams of shearing-force and bending-moment. Struts and ties. Triangular frames and trusses. Sheer legs. Cranes. Straining actions at any point of a loaded beam. Beams under a single load or uniformly distributed load. Work. Energy. Representation by curves. Curve of energy of piston (neglecting obliquity) and deduction of "Line of inertia." Hyperbolic expansion. Principle of virtual work. Kinetic energy. Curves of crank effort in simple cases. Dynamometers. Friction of bearings. Efficiency of machines.

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3. APPLIED MECHANICS AND STRENGTH OF MATERIAL.
(With Laboratory Work.)

Theory of Machines.—Fluctuation of energy and speed. Combined curves of crank effort. Governors. Alternating force and couple in frame in case of two cranks at right angles. Balancing of engines.

Statics of Structures.—Method of sections. King and queen post roofs, bowstrings, girders, and framework. Warren and Linville girders. Best position of supports for a horizontal uniformly loaded beam.

Stiffness and Strength of Materials.—Stress and strain. Hooke's law. Resilience of a bar. The tangential and normal stresses on any plane obtained by cutting a bar which is subjected to an axial pull. Combination of two simple pull or push stresses at right angles to each other. Ultimate stress. Proof stress. Elastic limit. Factor of safety. Strength of thin pipes. Bending of a beam or cantilever. The equations of bending

$$\frac{p}{y} = \frac{M}{I} = \frac{E}{R},$$

and application to beams of ordinary section. Distribution of shearing stress over the section of a beam or pin joint. Young's modulus obtained by deflection. Connection between bending moment and shearing force. Torsion of circular shafts. Strength of shaft to transmit given power. Twisting and bending combined in a shaft. Extension of spiral springs. Modulus of rigidity by static and kinetic methods.

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4. PHYSICS, HEAT, AND MAGNETISM.

General grounds for believing that the heat of a body consists of the motion of its particles. Evidence from familiar phenomena of conduction, evaporation, radiation, and the effects of mechanical agitation.

Temperature.—Steady temperature thermometry. Fahrenheit and Centigrade scales. Maximum and minimum thermometers.

Calorimetry.—Thermal units, Fahrenheit and Centigrade. Specific heats of solids and liquids; variation of specific heat with temperature. Water equivalents. Calculations involving specific heats.

Change of State.—Latent heat fusion. Latent heat of evaporation.

Melting and Solidifying.—Changes of volume. Black's and Bunsen's ice-calorimeters. Effect of change of pressure on melting point. General effect of salts in solution. Freezing mixtures.

Vaporization and Condensation.—Maximum vapor-pressure and its interpretation as a mobile equilibrium. Determination of the pressure of saturated water vapor at different temperatures. Super-position of pressures of mixed vapors and gases. Dalton's law. Ebullition. Circumstances affecting the boiling point. Formulæ for latent heat and total heat of steam. Conversion of formulas from Centigrade to Fahrenheit scale and the reverse. Spheroidal state. Hygrometry. Definition of humidity. Hygroscopes and gygrometers. Supersaturation of vapors and circumstances determining condensation. Influence of dust.

Conduction.—Good and bad conductors. Applications. Lagging of steam pipes. Dewar's vacuum lagging. Definition of coefficient of conduction. Flow of heat across boiler plates. Surface resistance. General consideration of conduction along a bar heated at one end.

Convection.—Currents produced in liquids and gases by local heating. Action of heating surface in boilers. Experiments on cooling. Heating of buildings by hot water. Draughts in chimneys.

Radiation.—Transfer of energy by radiation across apparently empty space. Newton's law of cooling. Reflection of heat from surfaces. Detection and measure of incident radiation. Comparison of the radiative powers of different substances. Laws of cooling. Transmission and absorption of radiation. Analysis of radiation by a prism. Luminous rays. Ultra-red and ultra-violet radiation. Conditions of efficiency in illumination. Principles of photometry. Practical applications depending on consideration of the radiative, absorptive, and reflective powers of different surfaces.

Mechanical Equivalent of Heat.—Demonstration of the conversion of work into heat, and the determination of the mechanical equivalent of heat. Principle of the conservation of energy. Natural sources of energy. Transformation of energy.

Expansion of Solids.—Forces exerted by expanding solids. Practical applications. Definition of the coefficient of linear expansion and its experimental determination. Coefficient of cubical expansion. Calculations. Examples of methods of compensating for expansion in physical instruments. Use of alloys with small coefficients of expansion. The course in heat is supplemented by laboratory work, including experiments in specific and latent heat.

Expansion of Liquids.—Change of density with change of temperature. Determination of absolute expansion of mercury. Use of mercury to gage vessels and determine their expansion. Expansion of other liquids. Expansion of water.

Expansion of Gases.—The laws of Boyle and Charles. Experimental determination of the coefficient of expansion of a gas by (1) method of constant pressure, and (2) method of constant volume. The absolute zero of temperature. Isothermal curves. Specific heat of a gas at constant pressure and at constant volume. Experimental determination of each.

Thermo-dynamics.—Conversion of heat into work. Availability of heat for transformation. Idea of efficiency in a heat engine. Cyclic process gone through by the working substance. Carnot's ideal reversible heat engine, with a perfect gas as working substance. Meaning of a Carnot cycle.

Magnetism.—The elementary properties of a magnet. Magnetic induction. Theory of molecular magnets. Experimental evidence. Lines of force. Field of force. Meaning of magnetic pole. The inverse square law. Expression of the force at any point on the axis of a thin magnet. Experimental verification. Comparison of magnetic force by the method of oscillations and by the method of deflections. Meaning of unit pole;

pole strength; field strength; magnetic moment. Intensity of magnetization; saturation; retentive power.

Terrestrial Magnetism.—Declination. Dip. Magnetic charts. Magnetism of iron ships. Different kinds of errors with compasses of iron ships and their correction. Magnetism of electro-magnets.

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5. ELECTRICITY.

Statical Electricity.—Phenomena: Production of charges by friction. Two kinds of charge. Conductors and non-conductors. Induction of charge. Distribution of charge on isolated conductors of different shapes. The proof plane. Absence of charge on interior surfaces. Influence of points in promoting discharge. Induction machines. Lightning rods. Di-electric strength. Leyden jars. Phenomena of disruptive discharge in ordinary air. Magnetization by discharge.

Measurements and Theory.—Definition of unit charge. Inverse square law. Coulomb's balance. The electric field. Electric exploring needle. Lines of force. Tubes of force. Electric potential. Expression for the potential at a point. Equipotential surfaces. The quadrant electrometer. Capacity. Condensers. Specific inductive capacity.

Current Electricity.—Earliest forms of voltaic cell. Measurement of potential difference between the terminals of a cell or pile. Definition of electromotive force of a cell. Chemical action in voltaic cells. Electrolysis. Phenomena and nomenclature. Polarization. Cells in common use. Clarke's cell of standard E. M. F. Protection of under-water fittings and boiler plates from local action. Faraday's quantitative laws of electrolysis. Chemical measure of current strength. Electro-chemical equivalents. Electro-plating. Storage cells, early development. Modern cells. Change of density of the liquid during charge and discharge. Behavior and management of storage cells. Oersted's discovery. Ampere's rule and its converse. Galvanoscope. Conditions for sensitiveness. Galvanometers. Tangent galvanometers. Method of small deflections. Thomson's mirror galvanometer. The d'Arsonval or moving coil galvanometer. Fall of potential along a current-bearing wire. Ohm's law. Definition of resistance. Methods of comparing resistances. Wheatstone's bridge. Comparison of low resistance. Resistance boxes. Specific resistance. Resistance of liquids. Change of resistance with change of temperature. Alloys suitable for resistance coils. Electro-magnetic system of units. Practical units. Divided circuits. Equivalent resistance. Shunts. Principle of superposition of currents. Kirchoff's laws. Joule's law of heating. The Watt. The Board of Trade "Unit." Mutual action between current-bearing wires. Instruments for practical electrical measurements. Service-pattern ammeters and voltmeters. Galvanometer arranged as ammeter and as voltmeter. Watt motor.

Electro-Magnets.—Solenoids. Force inside long solenoid. Effects of soft iron core. De-magnetizing influence of the poles. Specification of the magnetic qualities of iron. Permeability. Magnetic screening. Magnetic resistance and the magnetic circuit. Effect of air gaps.

Electro-Magnetic Induction.—Fundamental principles and laws. Rule for the direction of an induced E. M. F. Induction of E. M. F. round a complete circuit. Lenz's law. Phenomena due to mutual induction. Self-induction phenomena. Definition of coefficients of mutual and self induction. Ruhmkorff's induction coil. Influence of the condenser. Telegraphy. Morse transmitter. Duplex telegraphy. Relays. Localization of faults. Telephones. Microphonic transmitters. Arrangement of a telephone circuit.

Theory of Dynamos.—Ring and drum armatures. Separate, series, shunt, and compound windings. Armature reaction. Lead for brushes. Ex-

pression for the total E. M. F. of a dynamo. Output and efficiency of dynamos. Characteristic curves for series and shunt dynamos. Horse-power lines. Reason for using a shunt dynamo for charging cells. Multipolar dynamos; their advantages.

Electro-Motors.—Dynamos used as motors. Advantages of shunt-wound motors. Counter E. M. F. of a motor. Expression for rate work of a motor. Maximum rate of work. Efficiency of a motor. Transmission of electrical energy to a distance. Importance of high voltage. Efficiency of tranmission. Calculations.

Thermo-Electricity.—Thermo-electric power. Neutral point. Thermo-electric order. Peltier effect. Thermo-electric apparatus. Le Chatelier's pyrometer. Boys' radio-micrometer.

Platinum Thermometry.—The platinum degree. Calibration of a platinum thermometer. Whipple's indicator.

The Ballistic Galvanometer.—Correction for damping. Use with condenser. Calibration by means of standard induction coils. Method of determining magnetic field strength.

Wireless Telegraphy.—General principles. Oscillatory discharges. Syntonized circuits. Lodge's Leyden jar experiments. Coherers. Magnetic detector.

Principal Phenomena Observed with Discharges through High Vacua.—Cathode rays. Rœntgen rays. Their production and chief properties and probable nature.

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6. MECHANICAL DRAWING.

Introduction.—Rules for making drawings; plans, elevations, sections, and end views. Examples on the preceding, e. g., various views of nut and bolt and other simple objects. Scales.

Delineation of Plane Curves.—Ellipse, parabola hyperbola, helices, spirals, cycloidal curves. Intersection of solids of revolutions by planes. Construction of curves described by particular parts of machines or linkwork. Construction of curves from observed or tabulated data involving the geometrical use of abscissa and ordinate.

Forms of Teeth or Ordinary Spur and Bevel Wheels.—Meaning of the terms: Pitch, pitch line, root, point, addenda, face flank, etc. Sketches of wheel and other gearing. Sketches and working drawings of details of boilers, machinery, machine tools, etc.

Drawings.—Trial drawings to scale of some suitable machines or parts of machinery are to be made from the cadet's own rough sketches during the latter part of his course, and are to be presented as part of the final examinations.

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7. WORKSHOP APPLIANCES AND PRACTICE.

Measurement.—Preparation of straight edges and surface plates. Cutting tools—general principles; hand cutting tools for wood and for metals.

Machine Tools.—Early forms of lathes and successive improvements. Lathe tools, tool holders, and cutters. Gap, break, and face lathes. Speeds for cutting various materials. Drilling machines. Boring, plaining, slotting, and milling machines, punching and shearing machinery.

Materials and Processes.—Tool steel, hardening and tempering. Case hardening, annealing. Drilling tube plates. Flanging. Caulking. Ferruling. Galvanizing, tinning, soldering, brazing, etc. All the principle processes employed in turning, fitting, and erecting machinery in smith's and coppersmith's work; in boiler-making, pattern-making, in iron and brass foundries. Descriptions and sketches of the principal apparatus used.

Repairs.—Workshop repairs to worn and defective machinery.

Experimental Testing of Materials in the Testing Machine.—Testing of strength and ultimate extension. Curve of extension and load. Measurement of modulus of elasticity.

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8. GENERAL ENGINEERING LECTURES.

General.—Brief history of the steam engine; general description and properties of materials used; names, description, and use of various parts, viz.: Cylinder and fittings, including stuffing boxes and packing, pistons, piston rod, connecting rod, crank shaft and main bearings, thrust bearings, slide valve, including distribution of steam, eccentric, eccentric rod, reversing gears, and starting gear, double-ported valve, piston valve, general ideas of jet and surface condensers, general description of a boiler; different types of marine engines.

Steam.—Application of heat to water and the formation of steam at constant pressure. Definition of dry saturated steam, superheated steam, wet steam, specific volume, dryness, fraction of steam.

Temperature and Pressure.—Relation between temperature and pressure of saturated steam, boiling point, latent heat and sensible heat, total heat of formation of dry saturated steam under constant pressure. Relation between the pressure and specific volume of dry saturated steam. Relative volume of steam.

Heat and Work.—Conversion of heat into work; first law of thermodynamics. Joule's equivalent. Numerical examples on conversion of heat into work. External and internal work done during the formation of dry saturated steam under constant pressure.

Wet and Dry Steam.—Wet steam, formation under constant pressure compared with that of dry saturated steam, specific volume, total heat required, external and internal work done during formation. Superheated steam; total heat formation under constant pressure.

Action of Steam.—Formation of steam under constant volume. Heat required to raise the pressure of steam in a boiler. Numerical examples on the preceding. Expansion of steam. External work done during expansion. Graphic representation of the external work done during the formation and expansion of steam. Expansion curve. Preliminary consideration of the action of steam in the cylinder of an engine. Mean pressure on piston during forward stroke. Mean back pressure on piston. Graphic representation of the useful work done by the steam during one stroke of an engine. Useful work done per pound of steam used. Numerical examples. Calculation of horsepower. Use of the indicator diagram, and to find the mean effective pressure, the work done, and the horsepower.

Definitions.—Cylinder constant, stroke volume, volume swept through by piston per minute, mean speed of piston. Numerical examples.

Indicator Cards.—Construction of the theoretical indicator diagrams of simple engines; assumptions made. Methods of obtaining the mean effective pressure.

Curves.—Form of expansive curve and how its shape is affected by heat added to the steam during expansion with special reference to: (a) Hyperbolic expansion; (b) steam remaining dry and saturated throughout the expansion; (c) adiabatic expansion of dry saturated steam in a cylinder made of a perfectly non-conducting material.

Expansion.—Adiabatic expansion of wet steam. Action of the cylinder walls on the steam passing through an engine. Exhaust waste. Use of steam jacket. Comparison between the theoretical indicator diagram and the actual one. Effects of clearance on the actual ratio of expansion.

Efficiency.—Efficiency of the steam engine as an agent for transforming heat into mechanical work: (a) Non-expansive engine; (b) engine with

incomplete expansion; (c) with complete expansion; (d) perfect engine. General tabular statement of these examples compared with results of experiments. Causes of loss of efficiency.

Combustion.—Potential energy; origin, properties, approximate consumption, and uses of the different kinds of fuel. Nature of combustion. Caloric value of fuels. Evaporative value. Amount of air chemically and practically necessary for complete combustion. Losses of heat by incomplete combustion. Losses of heat by excessive supply of air. Changes during combustion of coal in ordinary furnaces. Arrangements necessary to perfect the combustion. Use of combustion chambers. Smoke prevention. Stoking. Flaming at funnel. Rates of combustion in furnaces of marine boilers. Temperature in furnace. Volume of products of combustion. Draught produced in funnel by difference of temperature. General remarks on natural draught and methods of accelerating the draught.

Oil as a Fuel for Boilers.—Composition and characteristics of the oil used. Calorific value. Flash point. Applications to a marine boiler: (1) Direct, (2) in conjunction with coal. Principles and details of burners. Fittings of furnaces for oil fuel. Installation on a warship. Storage and supply to furnaces. Conditions for efficient combustion.

Tank Boilers.—General description of types of tank boilers. Disposition of plating. Systems of riveting used for different parts. Details of construction of shell and plates, furnaces and combustion chambers. Methods of staying. Boiler mountings and fittings. Lagging. Uptakes. Air casings. Funnels. Boiler bearers. Efficiencies of heating surfaces. Causes of loss of evaporative power. Efficiencies of boilers.

Water-Tube Boilers.—Advantages and disadvantages of different types. Description and details of each type. Feed regulation; necessity for automatic regulators. Description of different types of feed regulators. Circulation of water. Circulation of hot gases. Safety arrangements. Furnace and ashpit doors. Fire extinguishers. Manufacture of solid drawn tubes. Treatment of tubes on receipt from makers. Tubing boilers. Apparatus for searching and cleaning tubes. Plugging defective tubes.

Forced Draft.—Methods of accelerating the rates of combustion of fuel and consequent increase of power to be obtained from a given number of boilers. Forced draft. Induced draft. Air screens and casings. Ventilation of engine and boiler rooms and coal bunkers.

Impurities in Feed.—Corrosion and preservation of boilers. Priming and its causes. Methods and instruments employed for ascertaining the density and amount of salt contained in water.

Boilers of Special Types.—Details of construction and working of various water-tube boilers: Belleville, Niclausse, Babcock and Willcox, Durr, Yarrow.

Condensers.—Surface condensers, air pumps, hot well pumps, circulating pumps, feed water filters.

Lubricants.—Lubricants and lubrication.

Indicators.—Uses of indicators. Descriptions of different kinds. Theoretical and actual indicator diagrams of compound engines. Effects on diagrams of faults of engine and of indicator. Combining diagrams.

Marine Engines.—Expansion by linking up. Throttling. Advantages and disadvantages of compound engines. Use of steam jackets. Steam turbines.

Resistance and Propulsion of Ships.—Paddles and screw. Consumption of fuel. Economical speeds. Determination of initial friction of machinery. Efficiency of mechanism. Details of construction of screw propellers. Propeller shafting. Stern tubes and bearings. Efficiency of propellers.

Evaporators and Distillers.—Description of leading types in the service. Closed exhaust system and valves, etc., in connection. Simple problems relating to efficiency of evaporators and distilling condensers. Low pressure evaporators.

Feed Pumps.—Description of leading types: Weir, Belleville, Worthington, and Admiralty pattern. Arrangements of feed suction and discharge pipes in modern ships. General arrangement of steam and exhaust pipes.

Steering Engines and Gear.—Action of and description of the leading types. Controlling shafting. Telemotor gear.

Capstan Engines and Gear.—Description. Calculation of strain on cable by action of steam pressure in cylinders.

Gas and Oil Engines.—General types. Otto cycle. Advantage of compression. Effects of scavenging. Use of producer gas: Dowson, Mond. Oils used in oil motors: Petroleum, petrol, etc. Use of crude oil. Methods of dealing with oil before combustion in various engines. Methods of ignition. Governing. Action of Crossley, Hornsby-Ackroyd, Diesel, and other engines. Examples with double action. Tests of consumption in gas engines and oil engines.

Experimental Trials of Engines.—Consumption of steam in relation to horsepower at various loads. The Willans line.

Miscellaneous.—Description of different types of electric lighting machinery, air compressing machinery, and refrigerating machinery used in the service. Procedure in fitting engines on board a vessel. Wear and adjustment of various parts of the machinery. Tests of machinery for receipt.

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9. METALLURGY.

Characteristic Physical Properties of the Useful Metals.—Tenacity. Ductility. Elasticity. Plasticity. Conductive power, etc.

Iron.—Occurrence in nature. Principal methods of extracting iron from its ores. Extraction as cast iron: Calcination. Smelting. Blast furnace and fittings. Hot and cold blast. Fluxes, etc. Chemical action in blast furnaces.

Cast Iron.—Manner in which carbon is associated. Varieties of cast iron. Chill casting. Remelting of cast iron. Foundry cupola.

Wrought Iron.—Chemical and other distinctions from cast iron. Manufacture from cast iron: Refining. Puddling. Reverberatory furnace. Removal of slag. Rolling mills. Piling, etc.

Steel.—Mechanical and physical properties. Chemical and other features distinguishing it from cast iron and wrought iron. Conversion of wrought iron into steel. Cementation. Blister steel. Conversion of blister steel into shear steel and into cast steel. Properties and uses of shear and cast steel.

Mild Steel.—Open-hearth and Bessemer processes. Steel castings. Wrought steel. Annealing. Blue heat. Precautions to be observed in working steel and plates.

Malleable Cast Iron.—Properties and uses of iron and steel. Cold shortness. Red shortness. Burnt iron.

Copper.—Occurrence in nature. Extraction from its ores by Welsh process. Removing iron and other foreign substances. Properties and uses of copper.

Tin, etc.—Properties and uses of tin, zinc, and lead.

Composition and Uses of Alloys.—Gunmetal and brass for various purposes. Naval brass. Muntz metal. Delta metal. Phosphor bronze. Solder and spelter. White metal for bearings, etc.

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10. DESIGN OF MACHINERY DETAILS.

Strength of materials used in machine construction. Physical and mechanical properties. The straining actions to which the different parts

of machinery are subject, and the influence of these actions in determining their dimensions. Stress. Strain. Ultimate stress. Limit of elasticity. Factor of safety, etc. Simple problems. Other considerations affecting design. Choice of materials.

Amount of steam space, and grate and heating surfaces allowed in boilers, and cooling surface in condensers.

The ordinary kinds of screw fastenings, proportion of nuts and bolts.

Design of the following: Single, double, and trebel lap and butt riveted joints for various uses, socket joints, knuckle joints, keys.

Detail design of piston rod (piston end only, not cross head), propeller shaft, and flange coupling.

Dimensions of cylinder and slide valve ports.

Zeuner's diagrams, and Müller circles.

Thickness of boiler shells and furnaces. Diameter and pitch of stays.

Diameter of safety valves. Compression of safety valve springs, etc.

Tests of materials ususally made to ensure their fitness for constructive purposes. Effects of heat on strength, etc., of steel iron, copper, and gun-metal.

APPENDIX F.

GENERAL STATEMENT OF REQUIREMENTS IN ENGINEERING FOR GRADUATION OF ENGLISH NAVAL CADETS UNDER THE PRESENT AMALGAMATION SYSTEM.

This system has been in operation so short a time that it has been found impracticable to present this information in full. It is fair to assume that the requirements for Keyham Engineering Graduates, given in Appendix E, are at least as high as those demanded of the Amalgamated Naval Cadets.

APPENDIX G.

PAPERS IN ENGINEERING OF GRADUATES OF A LEADING INSTITUTE OF TECHNOLOGY.

PHYSICS.

I.

State and illustrate the Second Law of Motion. Explain its relation to dynamical equilibrium. Does this law hold in electricity as well as in mechanics?

II.

Find magnitude and direction of resultant of the following forces acting at a point and in a plane: 6 lbs. at 30° to the X axis, 8 lbs. at 60°, 12 lbs. at 120°, and 4 lbs. at 210°. Define and illustrate center of parallel forces.

III.

Demonstrate formula for the centripetal force in a circular orbit. Explain construction, principle, and two uses of the Kater pendulum.

IV.

Explain in detail propagation of energy by waves. Give in some detail a discussion of sympathetic vibrations.

V.

Demonstrate that the pressure on base of a vessel is independent of its shape. Describe construction of some good form of mercurial barometer. Why are corrections made for temperature, capillarity, and elevation?

VI.

If 6000 cubic feet of water flow over a fall 120 feet high every minute, calculate the energy at the foot of the falls and the developed horsepower. If this energy is entirely converted into heat, calculate the heat in British thermal units. Neglect air resistance.

VII.

Discuss in detail construction, use, and theory of the electrophorus. Define intensity of electric field, capacity, difference of potential.

VIII.

Explain construction, theory, and use of the quadrant electrometer. What can you say regarding "velocity of electricity"? What happens on connecting a dynamo in series with a condenser? Answer in detail.

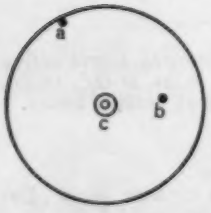
IX.

Given an air condenser charged with X units of electricity at a potential Y. If this condenser is joined in *parallel* with another condenser of the same size and shape but with a dielectric whose dielectric constant is K, calculate (1) final charge on each, (2) final potential of system, (3) energy before and after joining the condensers.

X.

Seventy-five storage cells, each of E. M. F. 2 volts and resistance $\frac{1}{3}$ ohm, are joined in series. These batteries are themselves in series with an incandescent lamp and with a resistance coil of 75 ohms. If the power supplied to the lamp is 50 watts, calculate (1) current, (2) resistance of lamp, (3) available voltage of circuit. What would be the value of the current if a coil of 200 ohms resistance were joined in parallel with the 75 ohm resistance?

MECHANISM.

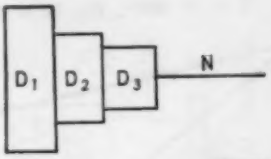


This disc makes 200 turns per minute.

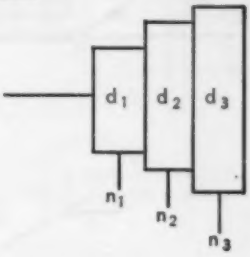
If *l.v.* of $a = 480$ inches per second, and *l.v.* of $b = 1800$ f. p. m., find the distances of a, and of b from c.

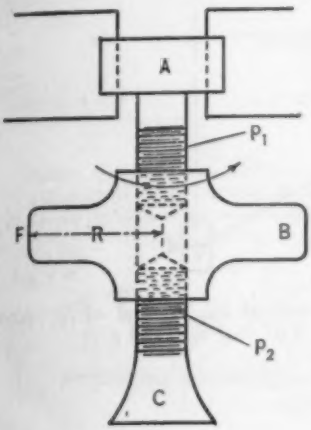
$D_1 = d_1 = 10''$
$D_2 = d_2$

$n_1 = 200$ r. p. m.
$n_2 = 60$ r. p. m.
$n_3 = 32$ r. p. m.

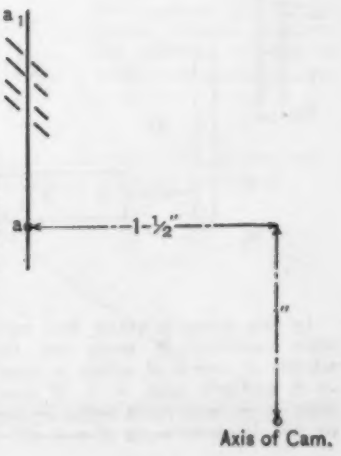


Find the turns of the upper shaft N and all the diameters, assuming the belt to be crossed.



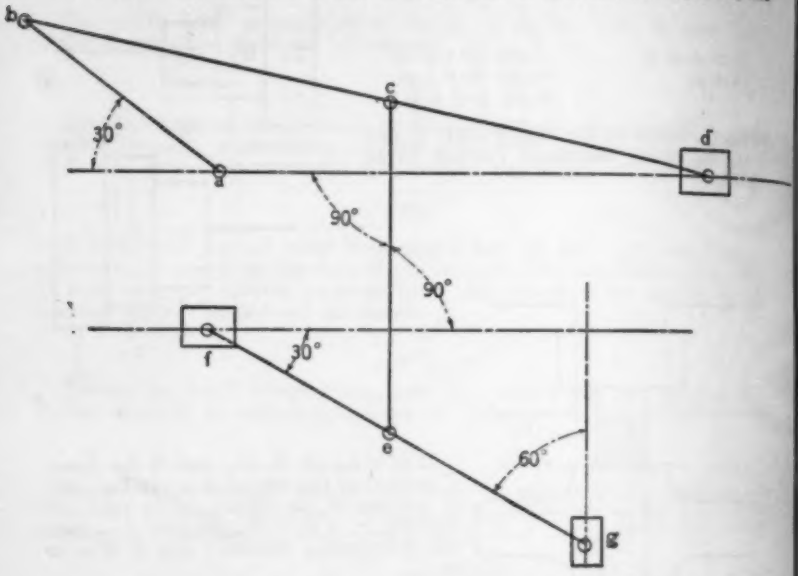


If $p_2 = 0.4$ in. R. H., and if the force F applied at the rim of B is 110 lbs., and if turning B, as shown, is to *raise* A, find the pitch p_1, if the load on A is 6000 lbs. (neglecting friction) and if $R = 10$ in.

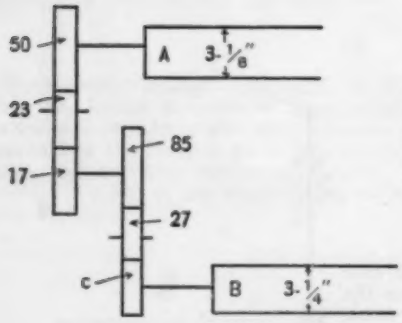


Draw the pitch line for a plate cam turning R. H. to move the point a on the straight line aa_1, up 2 in. with harmonic motion in ¼ turn of the cam; then a to drop 1 in. at once, still for ½ a turn, and then drop 1 in. and still ¼ turn.

Let $ab = 1\frac{1}{2}$ in., $bd = 5$ in., $bc = 2\frac{1}{2}$ in., $ce = 3$ in., $fg = 3\frac{1}{2}$ in., and



$ef = 1\frac{3}{4}$ in. Find the instantaneous centers of *bd*, *ce*, and of *fg*. Also let 1 in. represent the *l.v.* of *d*, find the *l.v.'s* of *b*, *c*, *e*, *f*, and *g*.

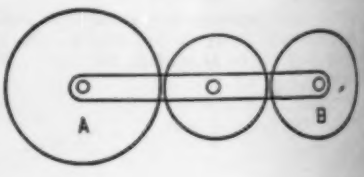


The points *A* and *B* 1 in. apart are to be connected by a pantograph so that *A* may move 3 in. while *B* moves parallel and similar to *A* 2½ in. Find the distance to the fixed point from *A*, and draw a pantograph.

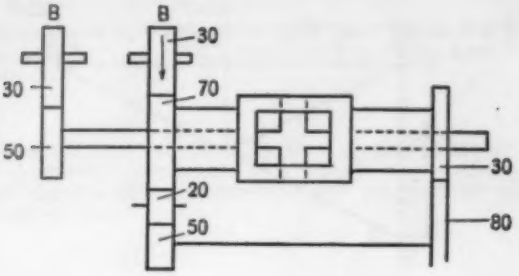
$$\frac{\text{The surface speed of } B}{\text{The surface speed of } A} = \frac{20}{1}$$

How many teeth must there be on the wheel *c*?

In this epicyclic train, find suitable numbers of teeth for the wheels *A* and *B* if, while *A* turns + 1 and the arm + 5, *B* shall turn + 20, and must there be one or two idles between *A* and *B*?



For 1 turn of A, as shown, how many turns of B, and which way?

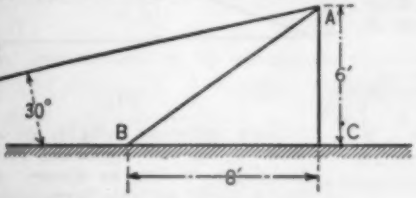


APPLIED MECHANICS.
Third Year.
Courses II, X, XIII.

I.

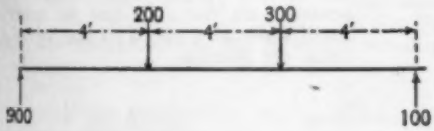
Deduce the formulæ for the magnitude and direction of the resultant of a system of forces acting in a single plane and applied at a single point by resolving into components along X and Y axes.

Fig. 2



II.

Find the stresses in AB and AC due to the force of 1000 lbs. acting as shown.



III.

Find the resultant of the system of parallel forces shown. Indicate the position of the resultant on sketch.

IV.

Prove that two statical couples lying in the same plane will balance when their moments are equal and they tend to turn in opposite directions.

V.

The beam AC is subjected to a uniformly distributed pressure of 2000 lbs. Find the stress in AB and the H and V components of the reaction at C. Assume strut AB hinged at A and B.

Fig. 5

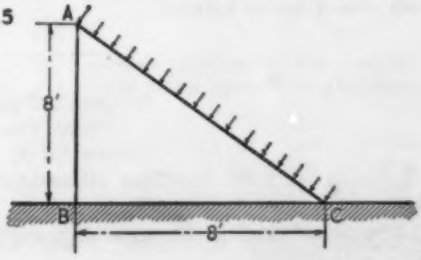
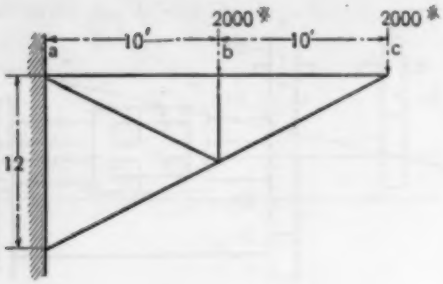


Fig. 6



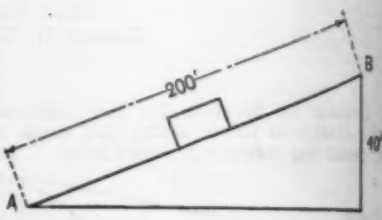
VI.

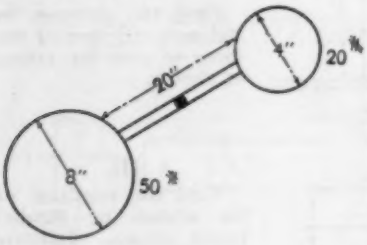
Find the stress in *ab* due to the loads of 2000 lbs. at *b* and *c*, as shown.

Fig. 7

VII.

A weight of 2000 lbs. is drawn up the inclined plane *AB* by a constant force of 600 lbs. If the velocity at *A* is zero and the friction between the weight and the plane is constant and equal to 100 lbs., what will the velocity be at *B*? What will be the work done in pulling the weight from *A* to *B*?





VIII.

Two spherical weights of 40 lbs. and 20 lbs. are connected by a rod weighing 10 lbs., as shown, and revolve about an axis perpendicular to the middle of the rod. Find the pressure on the axis due to centrifugal force at a speed of 300 revolutions per minute.

IX.

Deduce the formula for the force acting to produce harmonic motion.

X.

A solid cylinder, 4 ft. diameter, wt. = 2000 lbs., revolves on its axis at 200 *r. p. m.* Find its energy. Find force acting tangent to the rim which will stop it in one minute.

APPLIED MECHANICS.
Third Year.
Courses II, X, XIII.
Time allowed, 3 hours.

Answer the first ten questions.
Men conditioned in 1st term omit questions I and V, taking XI, XII, and XIII instead.

I.

Define the following terms, stating the units in each case: Modulus of elasticity, breaking load, working load, elastic limit, yield point or stretch limit, modulus of rupture.

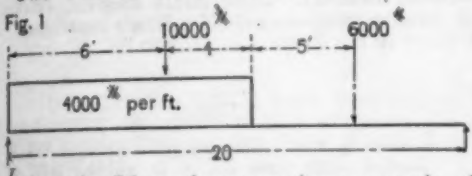
II.

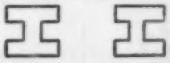
The center of pressure of a 6 ft. circular gate, in the side of a reservoir, is 3 in. below the center of gravity. The weight of a cubic foot of water = 62.5 lbs. Find the depth that the gate is submerged and the intensity of pressure at top and bottom of gate.

III.

Two I-beams are placed side by side and support the loads shown in Fig. 1. The greatest allowable fiber stress is 12,000 lbs. per sq. in. The sectional modulus $\frac{I}{y}$ of a 10 in. I-beam is 31.7; 12 in., 53.5; 15 in., 81.2; 18 in., 88.4. What depth of beam ought to be used?

Fig. 1

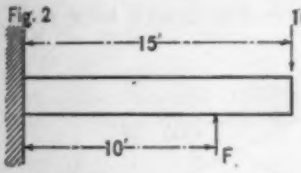




IV.

Given, the expressions for maximum deflection, and the deflection at a distance x from the origin as $\frac{Wl^3}{3EI}$ and $\frac{W}{EI}\left(\frac{lx^2}{2} - \frac{x^3}{6}\right)$ respectively, for the beam fixed at one end and loaded with a concentrated load W at the free end. Find the supporting force F for the beam shown in Fig. 2; also find the maximum shearing force and bending moment.

Fig. 2



V.

Deduce the formula for the maximum intensity of fiber stress in the case of a column subjected to an eccentric load.

VI.

Find the maximum fiber stress in a 4-in. shaft transmitting 150 H. P. at 100 r. p. m.

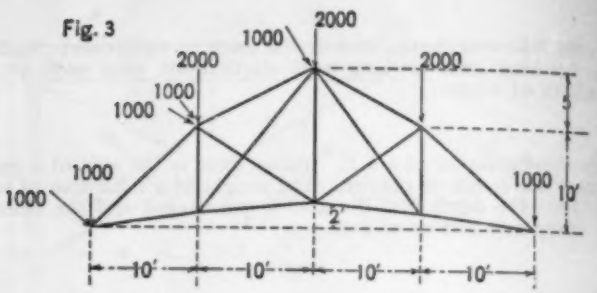
VII.

Assume four non-parallel forces and find their resultant by the funicular polygon construction. Prove that the construction gives the magnitude, direction, and line of action of the resultant.

VIII.

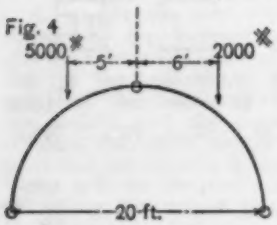
Given, the truss shown in Fig. 3, loaded as shown, wind from the left. Diagonals are tension members. Determine the supporting forces, using the funicular polygon construction. Assuming the reactions parallel to the resultant load. Plot the joint loads. Determine which diagonal is

Fig. 3



stressed in each panel (graphical method). Draw stress diagram, marking compression members + tension members —. Use Bow's notation. Scales: Space 1 in. = 10 ft. Force 1 in. = 2000 lbs.

Fig. 4



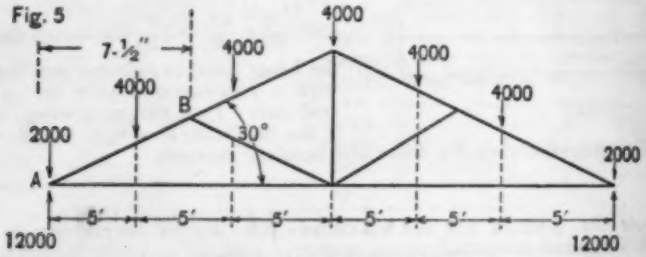
IX.

Given, the three-hinged circular arch loaded with 5000 lbs. 5 ft. to the left of the crown hinge and 2000 lbs. 6 ft. to the right of the crown hinge, find the H and V reactions at the hinges (algebraically).

X.

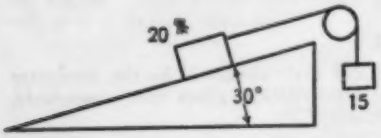
The rafters of the triangular truss, shown in Fig. 5, are 6 in. × 10 in.

Fig. 5



Find the maximum fiber stress in the member AB due to the loading shown.

Fig. 6



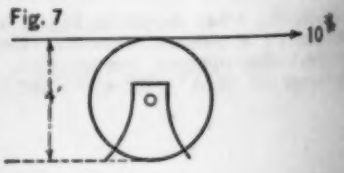
XI.

Find the accelerations of the weights and the tension in the string for the system shown in Fig. 6. Coefficient of friction = 1/10.

XII.

A cylinder, Fig. 7, moment of inertia = 2000 lb. ft. units, starting from rest, is acted upon for one minute by a force of 10 lbs. tangent to the rim. Find the resulting angular velocity and energy.

Fig. 7



XIII.

Prove that the centrifugal force of a solid body is the same in amount as if the whole mass were concentrated at the center of gravity.

STEAM ENGINEERING.

Third Year.

Time, 2 hours.

Courses II, III, X, XIII will answer any five of the last seven questions. Course VI will answer five of the first six questions.

I.

Sketch and explain some form of barometric tube condenser.

II.

Deduce expression for the work done and write expression for the heat added during an expansion of a gas along the line $Pv^n = P_1v_1^n = c$ from volume v_1 to volume v_2. Pressures P_1 and P_2 being pressures absolute on the square inch.

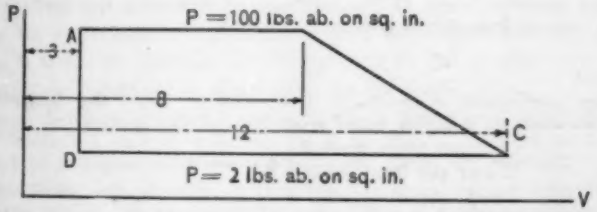
III.

Show that there is a change of intrinsic energy along a reversible adiabatic line. Show that there is also a change of temperature.

IV.

Explain the difference between a steam turbine of the Curtis type and one of the De Laval type.

V.



One pound of air having volume at A of 3 cu. ft. under 100 lbs. absolute pressure on the square inch works through the cycle $ABCDA$. Show graphically the changes of intrinsic energy between points A and B; B and C; C and D; D and A.

VI.

Find the heat received and rejected along each line in question No. V.

VII.

Three pounds of water at 201.98° F. are made into steam of temperature of 375.05° F. at 144 lbs. absolute pressure. How much heat is added; how much is the intrinsic energy increased? Write numerical statement for increase of entropy.

$$Pv = 93.5T - 971P^{\frac{1}{4}}$$

STEAM ENGINEERING.
Third Year.
Time, 3 hours.

Courses II, III, VI, X, and XIII answer any 8 of the 12 questions.

I.

(a) Prove that for perfect gases the intrinsic energy remains constant along an isothermal line.

(b) Find increase in entropy due to an isothermal expansion at 100° F. of one pound of a perfect gas from 100 lbs. absolute pressure to the sq. in. and a volume of 20 cu. ft. to a volume of 40 cu. ft. $Log_e 2 = .69$.

II.

Given, the equation $dQ = C_v dt + (c_p - c_v)\frac{T}{v}dv$, deduce equation for adiabatic line for perfect gas in terms of volume and temperature.

III.

Five pounds of water at 101.99° F. are vaporized into steam primed 2 per cent at 150 lbs. absolute pressure on sq. in. Find heat added, the increase in intrinsic energy, the final volume, and the increase in entropy.

IV.

What would be the lifting power of a balloon holding 10,000 cu. ft. of hydrogen, the temperature of the gas and of the surrounding air being 32°F.; barometer 28 in.

Specific volume of air = 12.4 cu. ft.
Specific volume of hydrogen = 178.8 cu. ft.

V.

Show by sketches some of the methods of stiffening the furnace tubes of Scotch and of Lancashire boilers.

VI.

Calculate equivalent evaporation from and at 212°, the boiler H.P., and the efficiency of a boiler plant from the following data:

Coal per hour, 5000 lbs.
Water per hour, 40,000 lbs.
Temp. steam, 452.85° F.
Pressure lbs. absolute per sq. in., 140 lbs.
Temp. feed water, 250.27° F.
Heat of combustion of coal, 14,300 B. T. U.

VII.

What is the object of a steam separator? Where are separators placed and what arrangements are made for draining them? Draw a sectional view of a separator and indicate the course of the steam.

VIII.

Sketch and explain some form of gas producer.

IX.

Explain the action of a two-cycle gas engine.

X.

Draw and compare the temperature entropy diagrams for compression of air from atmospheric pressure to any assumed pressure; first, in a single stage without cooling, and second, in a two-stage compressor with partial cooling in the cylinders and cooling to the original temperature in the intercooler.

XI.

Explain the differences between the non-conducting cycle and the Carnot cycle for a steam engine.

XII.

Deduce equation for the velocity of steam in the throat of a De Laval turbine nozzle. The steam enters the nozzle slightly superheated and is moist in the throat.

VALVE GEARS.

Explain clearly what is meant by a valve ellipse.

What does the Zeuner diagram represent, and give a geometrical proof for this.

What is meant by angular advance and why is any necessary?

Draw the Zeuner diagram for a piston valve, taking steam on the inside; given, H. E. lead 1/16 in., H. E. steam lap ¾ in., eccentricity 2 in., crank to connecting rod as 1:4; equal cut-off. C. E. exhaust clearance ¼ in.; equal compression. State what each valve circle in your figures represents, and indicate the crank positions for the various events of the stroke.

Show the positions of crank and eccentric when C. E. cut-off occurs.

What is meant by open and by crossed rods in link motion? and

What is the difference in their effect on the lead?

Draw a sketch showing an open rod connection for a plain slide valve moved through a rocker, with the crank on the C. E. dead point in mid gear and in full gear forward, showing the effect on the lead.

Double valve, cut-off valve on back of the main valve. Eccentricity of main valve 2½ in., H. E. cut-off by main valve at a crank position of 120° H. E. lead zero. H. E. cut-off by cut-off valve to occur at a crank position of 45°; clearance of cut-off valve 1 in., H. E. readmission when crank is on the C. E. dead point, find the auxiliary circle stating clearly what it represents; then find the eccentricity and angular advance of the cut-off valve's eccentric, and draw its valve circle; then from that for any crank position (say at 45°) the displacement of the plate on the main valve, as given by the auxiliary circle, is equal to the difference in the displacements, as shown by the respective valve circles.

If the travel of the cut-off valve on the main valve is constant, and if the cut-off valve is under the control of a shifting eccentric, draw a sketch which shall agree with your diagram, showing how the eccentrics can be arranged.

APPLIED MECHANICS.
Fourth Year.

I.

Deduce the three-moment equation for distributed loads, and explain the method of using it.

II.

A cord is suspended from two supports 100 ft. apart on the same level. The sag at the center is safe. Find the maximum tension stress in the cord due to a load of 100 lbs. per ft. of horizontal projection.

III.

Explain in detail how to find the outside fiber stresses at any section of an elastic arch, after the values of H, V, and M at one support have been determined.

IV.

Define (m). Determine the strains in terms of the stresses and the stresses in terms of the strains. (When the stresses are all parallel to one plane.)

V.

Given, the stresses upon two planes at right angles to each other, determine the resultant stress upon any given plane at the origin.

VI.

Given, the stresses upon two planes, not at right angles to each other, determine the principal stresses, both analytically and graphically.

APPLIED MECHANICS.
Fourth Year.
Courses II, III, X, XIII and XIII A.

I.

State what tests are commonly made to determine the quality of cast iron and give sketch of test specimens used. What results should be obtained from tests of gray iron castings?

II.

Give an account of tests made on full-sized cast iron columns. Give suitable value to use for the breaking strength of such a column.

III.

Give an account of Beardslee's tests on wrought iron used in making chain cables, stating the results obtained. How did the strength of the cable compare with that of the iron from which it was made?

IV.

What would be a suitable value to use for the modulus of rupture of wrought iron? What is the ratio of the modulus of rupture of cast iron to its tensile strength? (One value is not an answer in either case.)

V.

Give suitable values for tensile strength, yield point, and percentage of elongation for structural steel for buildings, bridges, and ships.

VI.

Give suitable values for the compressive strength and modulus of rupture of spruce, oak, and yellow pine. Give an account of the time tests of timber, stating results obtained.

VII.

What is the object of testing cement? Describe fully the methods to be used in making tests on Portland cement.

VIII.

What assumptions are made in calculating the friction of a bearing or a pivot? Deduce a formula for the moment of the friction of a flat circular pivot. (State assumption used.)

IX.

Deduce the formulæ to be used in calculating the power transmitted by a belt according to the "Ordinary Theory of Belting."

X.

Give an account of Tower's experiments for determining the coefficient of friction of lubricating oils, describing the machine used. What difficulties were encountered and how were they overcome? What results were obtained?

METALLURGY OF IRON.

I.

What are the differences between cast iron, steel, and wrought iron as regards percentage of carbon, form, malleability, and hardening power?

II.

Draw a vertical section through an iron blast furnace and mark on it the stock line, bosh line, tuyen line, slag tap, metal tap, bell and hopper, and downcomer.

III.

3. What are the reasons that an iron blast furnace always has a bosh and a narrowed smelting zone?

IV.

4. What is the resemblance and difference between the Whitwell and Cowper types of hot-blast stoves?

V.

Give the changes an ore charge undergoes in its descent through the blast furnace.

VI.

In foundry work, when would you use a green sand, a dry sand, a loam, an iron mould.

VII.

Describe with plan-sketch of furnace the puddling process.

VIII.

In Bessemerizing in an acid converter according to American practice: What furnishes the necessary heat? In what order are the foreign elements removed? How do you judge the end of a blowing? What is the object of adding spiegeleisen or ferromanganese; when and how do you add the one—the other?

IX.

Describe the general arrangement of the Siemens' regeneration system and the mode of operating it.

X.

What do you know about the uneven composition and the soundness of steel ingots cast from a Bessemer or open-hearth furnace?

XI.

Give an outline of the cementation process.

XII.

What do you understand by hardening, annealing, and tempering steel? How low in carbon may a steel run and still permit being hardened?

DYNAMICS OF MACHINES.

I.

Explain the construction, action, and graduation of the Emerson power scale.

II.

Explain how to study the action of both the pendulum and the fly-wheel governors, given their moment equations.

III.

Explain the action of the inertia governor. Describe some one form, and explain its mode of action.

IV.

Deduce expressions for the direct tension, the shearing force, and the bending moment at any point in the rim of a solid pulley, due to centrifugal force only.

V.

Deduce expression for the acceleration of the piston of a horizontal engine in terms of the speed of crank, crank length, and ratio of connecting rod to crank.

VI.

Given the acceleration f_1 of the cross-head pin, and that f_2 of the crank pin, in a horizontal direction, in the case of a horizontal engine, deduce the horizontal throw of the connecting rod, and its point of application.

VII.

With the same data, deduce the vertical throw of the connecting rod, and its point of application.

HYDRAULICS.

Fourth Year.

Courses II, III, VI, XIII.

Answer the *first two* questions and any *five* of the remainder. Reduced numerical answers are expected for problems. Accuracy of computation will be considered in marking.

I.

Derive an appropriate rule for the total pressure in a particular direction against a curved surface when variation of intensity may be disregarded.

II.

(a) For an inclined surface subjected to water pressure, which will be the lower, the center of gravity or the center of pressure? Give reason for your answer.

(b) What do you understand by the "impulse" of a jet, and how would you compute it?

(c) How would the discharge of a sharp-edged orifice be affected by shifting the orifice laterally from the center toward the side of the wall in which it might be placed, supposing the head maintained the same in both cases? Give reason for your answer.

(d) What is the distinguishing feature of Francis' formula for contracted weirs?

(e) What would be the limiting value of the coefficient of velocity at the throat of Francis' diverging tube, if reservoir and tube were in a vacuum? Give reason for your answer.

III.

Find entire pressure and center of pressure on a trapezoidal gate, the upper edge of which is 80 feet long, the lower edge 65 feet long, water standing 28 feet deep, level with the upper edge.

IV.

Across a small stream is constructed a plank dam, through which is cut a rectangular hole 12 inches wide and 6 inches deep. The water ceases to rise further when it stands 12 inches above the top of the orifice. What is the probable flow of the stream?

V.

A stream 50 feet wide and 4 feet deep is seen to have a mean velocity not exceeding 3 feet per second. For more accurate determination of the discharge a standard weir is to be built, extending entirely across the stream. Accepting the above as safe figures, to what height above the bed may the weir be carried without raising the original water level more than 3 feet? Disregard velocity of approach.

VI.

At what rate, in horsepowers, is energy being transmitted past a cross-section in a pipe line 24 inches in diameter, where the mean velocity is

10 feet per second and the gage pressure 50 lbs. per square inch? Supposing the pipes to terminate just beyond the gage in a nozzle whose coefficient of velocity is 0.97, what will be the corresponding velocity of the jet?

VII.

A level pipe line is abruptly enlarged from 4 inches to 8 inches diameter. The velocity in the 4-inch line is 16 feet per second. How many foot-pounds per second are probably wasted in heat at the change of section? If the pressure head during flow is 50 feet just up stream from the junction, what should it be just below where the stream has fully expanded again?

VIII.

In what ratio is the work against friction that is required from a fire engine in pumping 300 gallons per minute through 300 feet of 2½-inch hose ($f = 0.02$), to that required in pumping the same amount through an equal length of 3-inch hose ($f = 0.02$).

MARINE ENGINES.

Course XIII take first six questions.
Course II substitute VII and VIII for II and VI.

I.

What are the advantages and disadvantages of placing the condenser in the engine frame?

II.

Give sketch of thrust block indicating adjustments.

III.

Explain method of finding stresses in crank web.

IV.

Discuss the effects of free force and rocking couple for a three-crank engine.

V.

What are best locations for one-, two-, and three-crank engines with reference to nodes and loops of hull of ship.

VI.

Describe a steam-turning gear.

VII.

Deduce expression for efficiency of propulsion in terms of speed of ship and acceleration imparted to water.

VIII.

Determine dimensions by Barnaby's method for a ship which is to be propelled by a four-bladed screw at 17 knots by 2500 I. H. P., diameter not to exceed 12.5 feet.

APPENDIX H.

SPECIMEN EXAMINATION PAPERS OF APPLICANTS FOR UNITED STATES LICENSE AS CHIEF ENGINEER OF AN OCEAN-GOING STEAMER OF UNLIMITED TONNAGE, WITH STATEMENT OF ADDITIONAL REQUIREMENTS NECESSARY TO SECURE UNITED STATES MERCHANT ENGINEER LICENSES.

REQUIREMENTS WHICH MUST BE POSSESSED BY CANDIDATES WHEN THEY COME UP FOR EXAMINATION.

I.

Candidates for original licenses must appear in person for examination. License covers five years from face date.

II.

Original licenses are granted only after written examination.

III.

"No person shall receive an original license as engineer or assistant engineer (except for special license on small pleasure steamers and ferry boats of 10 tons and under, sawmill boats, pile drivers, boats exclusively engaged as fishing boats, and other similar small vessels) who has not served at least three years in the engineer's department of a steam vessel, a portion of which experience must have been obtained within the three years next preceding the application.

"Provided, That any person who has served three years as apprentice to the machinist trade in a marine stationary, or locomotive engine works, and any person who has served for a period of not less than three years as a locomotive or stationary engineer, and any person graduated as a mechanical engineer from a duly recognized school of technology, may be licensed to serve as an engineer of steam vessels after having had not less than one year's experience in the engine department of steam vessels, a portion of which experience must have been obtained within the three years preceding his application; which fact must be verified by the certificate, in writing, of the licensed engineer or master under whom the applicant has served, said certificate to be filed with the application of the candidate; and no person shall receive license as above, except for special license, who is not able to determine the weight necessary to be placed on the lever of a safety valve (the diameter of valve, length of lever, distance from center of valve to fulcrum, weight of lever, and weight of valve and stem being known) to withstand any given pressure of steam in a boiler, or who is not able to figure and determine the strain brought on the braces of a boiler with a given pressure of steam, the position and distance apart of braces being known, such knowledge to be determined by an examination in writing, and the report of examination filed with the application in the office of the local inspectors, and no engineer or assistant engineer now holding a license shall have the grade of the same raised without possessing the above qualifications. No original license shall be granted any engineer or assistant engineer who cannot read and write and does not understand the plain rules of arithmetic."—(R. S., Sec. 4411.)

IV.

CLASSIFICATION OF ENGINEERS.

Chief.

"Chief engineer of ocean steamers.
"Chief engineer of condensing lake, bay, and sound steamers.
"Chief engineer of non-condensing lake, bay, and sound steamers.
"Chief engineer of condensing river steamers.
"Chief engineer of non-condensing river steamers.
"Any person holding chief engineer's license shall be permitted to act as first assistant on any steamer of double the tonnage of same class named in said chief's license.
"Engineer's of all classifications may be allowed to pursue their profession upon all waters of the United States in the class for which they are licensed.

"First Assistant.

"First assistant of ocean steamers.
"First assistant engineer of condensing lake, bay, and sound steamers.
"First assistant engineer of non-condensing lake, bay, and sound steamers.
"First assistant engineer of condensing river steamers.
"First assistant engineer of non-condensing river steamers.
"Engineers of lake, bay, and sound steamers, who have actually performed the duties of engineer for a period of three years, shall be entitled to examination for engineer of ocean steamers, applicant to be examined in the use of salt water, method employed in regulating the density of the water in boilers, the application of the hydrometer in determining the density of sea water, and the principle of constructing the instrument; and shall be granted such grade as the inspectors having jurisdiction on the Great Lakes and seaboard may find him competent to fill.
"Any assistant engineer of ocean steamers of 1500 gross tons and over, having had actual service in that position for one year, may, if the local inspectors, in their judgment, deem it advisable, have his license indorsed to act as chief engineer on lake, bay, sound, or river steamers of 750 gross tons or under.
"Any person having had a first assistant engineer's license for two years and having had two years' experience as second assistant engineer, shall be eligible for examination for chief engineer's license.

"Second Assistant.

"Second assistant engineer of ocean steamers.
"Second assistant engineer of condensing lake, bay, and sound steamers.
"Second assistant engineer of non-condensing lake, bay, and sound steamers.
"Second assistant engineer of condensing river steamers.
"Any person having had a second assistant engineer's license for two years and having had two year's experience as third assistant engineer, shall be eligible for examination for first assistant engineer's license.

"Third Assistant.

"Third assistant engineer of ocean steamers.
"Third assistant engineer of condensing lake, bay, and sound steamers.
"First, second, and third assistant engineers may act as such on any steamer of the grade of which they hold license, or as such assistant engineer on any steamer of a lower grade than those to which they hold a license.

"Any person having a third assistant engineers license for two years and having had two years' experience as oiler or water tender since receiving said license, shall be eligible for examination for second assistant engineer's license.

"Inspectors may designate upon the certificate of any chief or assistant engineer the tonnage of the vessel on which he may act.

"Any assistant engineer may act as engineer in charge on steamers of 100 tons and under. In all cases where an assistant engineer is permitted to act as engineer in charge, the inspectors shall so state on the face of his certificate of license without further examination."—(R. S., Sec. 4441.)

V.

A license may be renewed without examination under the following rule:

"Whenever an officer shall apply for a renewal of his license for the same grade the presentation of the old certificate shall be considered sufficient evidence of his title to renewal, which certificate shall be retained by the inspectors upon their official files as the evidence upon which the license was renewed: Provided, that it is presented within twelve months after the date of its expiration, unless such title has been forfeited, or facts shall have come to the knowledge of the inspectors which would render a renewal improper; nor shall any license be renewed in advance of the date of the expiration thereof, unless there are extraordinary circumstances that shall justify a renewal beforehand, in which case the reasons therefor must appear in detail upon the records of the inspectors renewing the license."—(R. S., Sec. 4405.)

"Before an original license is issued to any person to act as a master, mate, pilot, or engineer, he must personally appear before some local board or a supervising inspector for examination; but upon the renewal of such license, when the distance from any local board or supervising inspector is such as to put the person holding the same to great inconvenience and expense to appear in person, he may, upon taking oath of office before any person authorized to administer oaths and forwarding the same, together with the license to be renewed to the local board or supervising inspector of the district in which he resides or is employed, having the same renewed by the said inspector, if no valid reason to the contrary be known to them; and they shall attach such oath to the stub end of the license which is to be retained on file in their office: *Provided, however,* that any officer holding a license, and who is engaged in a service which necessitates his continuous absence from the United States, may make application in writing for one renewal and transmit the same to the board of local inspectors with a statement of the applicant, verified before a consul or other officer of the United States authorized to administer an oath, setting forth the reasons for not appearing in person, and upon receiving the same the board of local inspectors that originally issued such license shall renew the same for one additional term of such license, and shall notify the applicant of such renewal."—(R. S., Sec. 4445.)

VI.

Raises in grade of license are made under the following rule:

"Licensed officers serving under five years' license, entitled by license and service to raise of grade, shall have issued to them new licenses for the grade for which they are qualified, the local inspectors to forward to the supervising inspector-general the old license when surrendered with the report of the circumstances of the case. But the grade of no license shall be raised, except as hereinafter provided, unless the applicant can show one years' actual experience in the capacity for which he has been licensed."—(R. S., Sec. 4405.)

VII.

The following recommendations are required of applicants:

"Inspectors shall, before granting an original license to any person to act as an officer of a vessel, require the applicant to make his written application upon the blank form authorized by the board of supervising inspectors, which application shall be filed in the records of the inspectors' office. Inspectors shall also, when practicable, require applicants for pilot's license to have the written endorsement of the master and engineer of the vessel upon which he has served, and of one licensed pilot, as to his qualifications. In the case of applicants for original engineer's license, they shall also, when practicable, have the indorsement of the master and engineer of a vessel on which they have served together with one other licensed engineer."—(R. S., Sec. 4405.)

VIII.

"Any applicant for license who has been duly examined and refused may come before any local board for re-examination after one year has expired."—(R. S., Sec. 4405.)

IX.

"Any person who has served at least one year as master, commander, pilot, or engineer of any steam vessel of the United States in any service in which a license as master, mate, pilot, or engineer was not required at the time of such service, shall be entitled to license as master, mate, pilot, or engineer, if the inspectors, upon written examination as required for applicants for original license, may find him qualified: Provided, that the experience of any such applicant within three years of making application has been such as to qualify him to serve in the capacity for which he makes application to be licensed."—(R. S., Sec. 4445.)

"No person holding special license (Form 878) shall be eligible for examination for a higher grade of license until such person has actually served two full seasons under the authority of his license, and one additional full season in a subordinate capacity upon steamer requiring regularly licensed officers."—(R. S., Sec. 4405.)

X.

"No original master's, mate's, pilot's, or engineer's license shall be issued hereafter or grade increased except upon written examination, which written examination shall be placed on file as records of the office of the inspectors issuing said license; and, before granting or renewing a license, inspectors shall satisfy themselves that the applicants can properly hear the bell and whistle signals."—(R. S., Sec. 4405.)

SAMPLE EXAMINATION PAPER OF APPLICANT FOR UNITED STATES LICENSE FOR CHIEF ENGINEER OF OCEAN-GOING STEAMER OF UNLIMITED TONNAGE.

I.

An application for a set of such questions was made to the Supervising Inspector-General of the Steamboat Inspection Service, Department of Commerce and Labor, who replied:

"This office has no sample sets of questions asked at examinations for licensing engineers, and at any rate these questions are not for public distribution."

II.

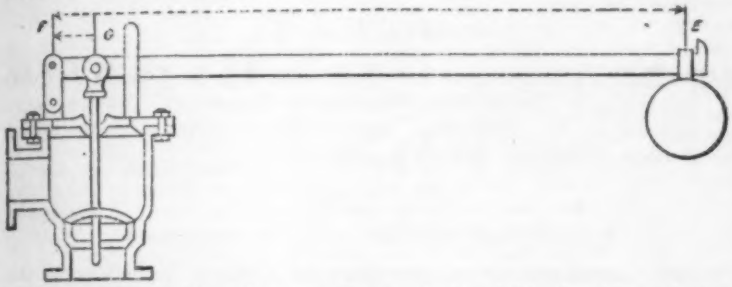
The following are some of the questions that have been asked of applicants for such license:

A. Required by Law.—(R. S., Sec. 4441.)

(NOTE.—These two questions cover the only knowledge specifically demanded by the law. They are presented to the applicant on a regular printed form, and apparently are invariable for every examination, except that the figures are different in different cases.)

I.

With a safety valve 5 inches in diameter, with 164 lbs. steam pressure; length of lever, 36 inches; distance from center of valve to fulcrum, 5



inches; actual weight of lever, 22 lbs.; actual weight of valve and stem, 8 lbs. What weight would be required at the end of the lever?

II.

With flat surfaces of a boiler stayed 7½ inches from center to center of stays, with 164½ lbs. of steam, what is the strain on each stay?

B. Questions Asked by Inspectors, but Not Specifically Required by Law Like the Preceding Two.

I.

What will be the pitch of a propeller 17 feet in diameter, having a blade 3 feet wide, the forward edge being 15 inches in advance of the after edge?

II.

What will be the capacity of a bunker 18 feet long, 15 feet wide, and 12 feet deep, allowing 64 pounds per cubic foot?

III.

How many gallons of water will a tank contain that is 16 feet in diameter, and 14 feet high?

IV.

Sketch and describe an indicator card.

V.

How many stays will a flat surface require, allowing ½ stay on each side of the sheet; the sheet being 8 feet long and 6 feet wide, stays spaced 8 inches center to center.

VI.

How many knots will a steamer make by the wheel in 24 hours, having a propeller 24 feet pitch, making 75 revolutions per minute, allowing 9% slip?

(NOTE.—It is understood that, in these examinations, the examination itself has a weight of only ten per cent, the general qualifications of the candidate, his experience, etc., as passed upon by the inspectors, having a weight of ninety per cent. It will be noted that this places the decision entirely in the hands of the local inspectors.

APPENDIX I.

REQUIREMENTS DEMANDED OF APPLICANTS FOR BRITISH LICENSE AS CHIEF ENGINEER OF OCEAN-GOING STEAMER OF UNLIMITED TONNAGE, WITH STATEMENT OF ADDITIONAL REQUIREMENTS NECESSARY TO SECURE BRITISH MERCHANT ENGINEER LICENSES.

QUALIFICATION FOR CERTIFICATES OF COMPETENCY.

Second-Class Certificate.—A candidate for a second-class engineer's certificate must be twenty-one years of age.

(a) He must have served an apprenticeship to an engineer for three years at least, and prove that during the period of his apprenticeship he has been employed on the making and repairing of engines; or, if he has not served an apprenticeship, he must prove that for not less than three years, he has been employed as a journeyman mechanic in some factory or workshop on the making or repairing of engines. In either case he must have served one year at sea in the engine room as an engineer on regular watch in the foreign, home, or coasting trade (two-thirds only of the length of service in the home or coasting trade is reckoned towards sea service); or

(b) He must have served at least four years at sea in the engine room as an engineer on regular watch in the foreign, home, or coasting trade.

(c) He must be able to give a description of boilers, and the methods of staying them, together with the use and management of the different valves, cocks, pipes, and connections.

(d) He must understand how to correct defects from accident, decay, etc., and the means of repairing such defects.

(e) He must understand the use of the barometer, thermometer, and salinometer, and the principles on which they are constructed.

(f) He must state the causes, effects, and usual remedies for incrustation and corrosion.

(g) He must be able to state how a temporary or permanent repair could be effected in case of derangement of a part of the machinery, or total break down.

(h) He must write a legible hand, and understand the first five rules of arithmetic, and decimals, and their application to questions about con-

sumption of stores, and full capacities of tanks and bunkers, the duty of pumps, and the direct strains in engines and boilers.

(i) He must be able to pass a creditable examination as to the various constructions of paddle and screw engines in general use; as to the details of the different working parts, external and internal, and the use of each part.

(j) He must possess a creditable knowledge of the prominent facts relating to combustion, heat, and steam.

First-Class Engineer.—A candidate for a first-class engineer's certificate must be twenty-two years of age.

In addition to the qualifications required for a second-class engineer:

(a) He must either possess or be entitled to a first-class engineer's certificate of service; or, in the event of his not being so possessed or entitled, he must have served for one year at sea as second engineer in a foreign-going steamship or a home-trade passenger steamship with a second-class engineer's certificate of competency valid in the United Kingdom, or for two years at sea as second engineer with a second-class engineer's certificate of service, or having served one year at sea as second engineer with a second-class engineer's certificate of service, he must show, in addition, at least six months' service as chief engineer in a vessel required by law to carry at least one engineer holding a certificate. The examiner should therefore be satisfied that an applicant for a first-class engineer's certificate has not only been *in possession* of a second-class certificate for the periods above stated, but that he has actually *served* for such periods in the engine room, at sea, with a second-class certificate, in the capacities referred to, and that his name has been entered in the articles of agreement accordingly.

(b) He will be required to make an intelligible hand sketch or a working drawing of some one or more of the principal parts of a steam engine, and to mark in, without a copy, all the necessary dimensions in figures, so that the sketch or drawing could be worked from.

(c) He must be able to take off and calculate indicator diagrams.

(d) He must be able to calculate safety-valve pressures, and the strength of the boiler shell, stays, and riveting.

(e) He must be able to state the general proportions borne by the principal parts of the machinery to each other, and to calculate the direct stress, the torsional stress, and the bending stress in round bars, and the direct stress in rectangular bars with given loads.

(f) He must be able to explain the method of testing and altering the setting of the slide valves, and to sketch about what difference any alteration in the slide valve will make in the indicator diagram, and also the method of testing the fairness of shafts, and of adjusting them.

(g) He must be conversant with surface condensation, superheating, and the working of steam expansively.

(h) His knowledge of arithmetic must include the mensuration of superficies and solids, the extraction of the square root, and the application of these rules to questions relating to the power, duty, and economy of engines and boilers, and to the stresses in rods, shafts, and levers of engines.

Examination for an Extra or Honorary Certificate.—This examination is voluntary; it is held once in three months only, and extends over several

days; notice must be given at least one week before the date of examination.

If the candidate passes he will receive the certificate at once, without being required to have served two years at sea with a first-class engineer's certificate of competency, as formerly.

(a) The candidate must possess a thorough knowledge of the construction and working of the different forms of marine engines and propellers in all their parts, and be so far acquainted with the elements of theoretical mechanics as to comprehend the general principles on which the machine works, and to illustrate his knowledge of these principles by numerical examples.

(b) He must possess a knowledge of the theory of strain and stress sufficient to be able to deduce the ordinary rules for the bending of rectangular bars, and for the twisting and bending of round bars.

(c) He must be acquainted with the principles of expansion and the modern theory of heat; and be able to solve, with the assistance of his own book or without books, according as the examination papers may be set, questions in economy and duty in connection with engines and boilers.

(d) He must understand how to apply the indicator, and to draw the proper conclusion from the diagrams, and to construct the approximate diagrams for any given data.

(e) He must be able to produce, without a copy, a fair working drawing of any part of the machinery, with figured dimensions fit to work from.

(f) He must understand the principles of the action of the screw propeller and the paddle wheel, and must be able to estimate numerically the effect, in speed of ship, and consumption of fuel, due to any alteration in pitch, diameter, revolutions, etc.

(g) He must be able to give a description of boilers and the methods of staying them, and must show that he possesses a knowledge of the theoretical principles which regulate their construction, and that he is able to calculate the strength of the boiler shell, stays, and riveting.

(h) He must understand the general nature of the strains and stresses produced by the steam pressure, and by the expansions due to unequal temperatures in boiler shells.

(i) He must have a knowledge of safety valve construction and the principles involved in determining the size of a safety valve, and the construction of spring-loaded and dead-weight valves.

(j) He must possess a thorough knowledge of the theory of combustion; the chemical composition of fuels; the evaporative duty of fuels of given composition; the production of draft; the effect in regard to economy, safety, and wear and tear, of increasing or diminishing the proportion of heating surface, of grate-bar surface, of area of section of air passages, of area of water surface, of steam space capacity and water capacity.

(k) He must be able to explain the formation of scale and the precipitation of salt, and the precautionary means adopted in respect thereto, with jet condensers, and with surface condensers.

(l) He must understand the general principles involved in the construction of the barometer, thermometer, salinometer, and steam and vacuum gages.

(m) He must be familiar with the general results obtained from past experience in relation to corrosion, pitting, and galvanic action in boilers, and the use of zinc and of soda in boilers.

(n) He must give a variety of illustrations of how defects have arisen from accident, imperfect construction, or deterioration, and how these defects might have been prevented, and the best way of repairing such defects.

(o) He must possess an intelligent knowledge of the properties of the lubricants, boiler cements, and indiarubber in general use in steamers.

(p) He must understand the causes of spontaneous combustion, and the formation of explosive gases in coal holds, and the precautionary measures proper to prevent accidents from these causes.

(q) The candidate may, with his application to be examined, send in questions set by himself and worked in his own way without books. These must be forwarded to the chief examiner of engineers. This is to afford him an opportunity of showing to the best advantage what he knows. Questions based upon these examples will be afterwards put before him to test the soundness of that knowledge.

(r) To give scope to test the information and reasoning power of the candidate, the question may be framed upon any well understood objects, such as are employed in text-books to illustrate the action of some principle of engineering science.

Engineers and assistant engineers in the Royal Navy are at liberty to apply for certificates of service, and to be examined for certificates of competency in the mercantile marine; but the Lords Commissioners of the Admiralty have directed that the applications of officers on the active list should be made through their commanding officer, and that the applications of officers on half pay should be made to the secretary of the Admiralty, who in either case will forward the application to the Board of Trade.

An assistant engineer R. N., may be examined for a second-class certificate of competency, and an engineer, R. N., for a first-class certificate.

Temporary active service as engineer in the Royal Navy counts in applications for certificates of competency in the same way and to the same extent only as in the case of the service of mercantile marine engineers; that is to say, so much of the applicant's time as is spent in active service at sea, or in a ship commissioned for sea service, counts as "sea service"; and so much of the applicants time as is spent in active service on board ship in harbor, and not commissioned for sea, counts as workshop time.

Service performed in the capacity of engine-room artificer may count to qualify a candidate for examination for a second-class engineer's certificate of competency in the mercantile marine. If the service has been on shore it will only count as workshop time. If in the engine room at sea the candidate must prove that during such service he had charge of an engine-room watch.

(NOTE.—A comparison of the above freely published statement with the preceding appendix, with its reticence as to the requirements necessary to secure a United States license, may in a measure explain the attitude generally found to exist among English mechant engineers towards our license.)

APPENDIX J.

STATEMENT OF OFFICERS OF THE UNITED STATES NAVY AVAILABLE FOR ENGINEERING DUTY AS SHOWN BY NAVY REGISTER OF JULY 1, 1905, AND AS AVAILABLE UNDER THE LAW IN FORCE PRIOR TO MARCH 3, 1899.

AT PRESENT DATE.

Active List.

1. Ex-engineer captains, for shore duty only, engineering only	5
2. Ex-engineer commanders, for shore duty only, engineering only	17
3. Ex-engineer lieutenant-commanders for engineering duty afloat or ashore until promoted and then ashore only	21
4. Ex-engineer lieutenant-commanders for any duty	18
5. Ex-engineer lieutenants for any duty	62
6. Ex-line officers whose experience fits them for engineering duty:	
Lieutenant-commanders	25
Lieutenants	40
7. Ensigns who were formerly warrant machinists	3
8. Warrant machinists	176
Total	367

Retired List on Duty.

1. Ex-engineer rear-admirals	4
2. Ex-engineer commodores	1
3. Ex-engineer captains	3
4. Ex-engineer commanders	14
5. Ex-engineer lieutenants	1
6. Chief engineers	1
7. Passed assistant engineers	3
8. Assistant engineers	2
9. Warrant machinists	3
Total	32

Summary.

Total active list available	367
Total retired list on duty	32
Total	399

Prior to Passage of Personnel Bill Under Section 1390, Revised Statutes.

1. Chief engineers	70
2. Passed assistant engineers	60
3. Assistant engineers	40
Total	170

(NOTES.—(1) Midshipmen (or naval cadets) performing their two-year undergraduate cruise, are not included in either of the above. Such have been and still are more or less available for subordinate engineering duty. (2) The numbers given for officers of the old line available at the present day whose experience fits them for engineering duty are merely personal estimates by the writer of this paper. Readers may wish to recast them for themselves, in accordance with their own experience. It is believed

that the numbers as given are conservative, however, and even if such officers were wholly omitted from the list, the point of the argument deduced from this appendix would still exist in full force.)

APPENDIX K.

STATEMENT OF NUMBER OF GRADUATES OF THE UNITED STATES NAVAL ACADEMY AVAILABLE EACH YEAR UNDER THE PRESENT LAW FROM WHICH TO SELECT ENGINEERING EXPERTS, AND STATEMENTS OF THE SAME UNDER THE LAW IN FORCE PRIOR TO MARCH 3, 1899.

Under Old Law.

Maximum possible number of cadets in existence at any one time under laws in force on March 2, 1899:

1 for each Representative of Congress	357
1 for each Delegate in Congress	4
By the President, at large	10
By the President, from the District of Columbia	1
Total number allowed by law	372
As the above covers six classes, in order to get the maximum average number of graduates possible in each year we must divide by six, and get	62

Under Present Law.

2 for each Representative in Congress	772
2 for each Delegate in Congress	8
2 for each Senator in Congress	180
5 each year by the President, at large	20
By the President, from the District of Columbia	2
From Porto Rico	1
Total number allowed by law	983
As the above covers four classes, in order to get the maximum average number of graduates possible in each year we must divide by four, and get	245.6

Summary.

We therefore see that, whereas prior to the passage of the Personnel Bill, engineers could be selected from a maximum average number of 62 graduates yearly, under the present law the selection can be made for engineering duty from a maximum number of 245 graduates yearly, or from nearly four times as many.

The above figures are on the basis that every midshipman who enters graduates, and the actual figures are therefore considerably too high. It appears from the Naval Academy registers as though the percentage of failures is less now than in the years just preceding 1899, and while the totals given are too high, as stated, it appears that the proportion is even more in favor of the present system than that given. It is certainly no lower. It is therefore true that selections for engineering experts can now be made from at least five times the number of graduates that were available prior to the passage of the Personnel Bill.

APPENDIX L.

DESCRIPTION OF PRESENT PLANT FOR INSTRUCTION IN ENGINEERING AT THE UNITED STATES NAVAL ACADEMY, WITH STATEMENT OF THE USE MADE OF THESE FACILITIES.

DESCRIPTION OF PLANT.

(NOTE.—This description is taken largely from a paper on the subject by the head of the Department of Engineering and Naval Construction at the Naval Academy, Commander J. K. Barton, U. S. N., a member of the old engineer corps of the navy, which paper appeared in the *Journal of the American Society of Naval Engineers*, Vol. XVII, No. 1.)

The new building contains:

Model Room.—This contains types of the different auxiliaries, air, circulating, and feed pumps, etc., found on board naval vessels; sectional models; valves and valve gearing; models of triple and quadruple expansion engines; indicators; types of steam turbine vanes; model of steam steering and capstan engines; full-size working model of the *U. S. S. Connecticut's* reversing engines; reversible ash hoist engines; sectional and working models of steam launch engines; working model of valve gear and link motion; elements of Niclausse, Babcock and Willcox, and Cahall boilers; together with the various naval construction models in the way of sections of various types of ships; and working models of machinery under the cognizance of the Bureau of Construction and Repair. Various instruments of precision, as well as fuel and gas-testing apparatus, are also provided.

Mechanical Laboratory.—This contains 1 air compressor; 2 Wheeler condensers; 1 triple-expansion experimental engine with tank; 1 dense air and 1 ammonia ice machine; 1 evaporating plant with pumps and distiller; 1 sixteen-kilowatt marine direct-connected generator; 1 twenty-five kilowatt generator driven by a Curtis steam turbine; 1 fifteen horsepower De Laval steam turbine; 1 Riehle testing machine; 1 complete set of pneumatic tools, with all attachments; 2 engines for disassembling, making adjustments, etc.; 1 Root blower; and Prony brakes, dynamometers, and engine- and boiler-testing apparatus.

Woodworking Shop.—The equipment consists of 18 woodworking lathes; 1 power-driven band saw; 1 power saw bench; several hand-power tools and benches. The power-machinery is motor driven.

Machine Shop.—The equipment consists of the following tools, part driven by motors and part by belts and shafting: 37 lathes, from 14 in. to 27 in. swing; 4 planers; 6 shapers; 4 drill presses; 3 sensitive drilling machines; 1 combined drilling and slotting machine; 3 milling machines; 3 slotting machines; 1 radial drill; 1 spliner; 1 grinding machine; 2 boring machines; 1 pipe cutting machine; 3 tool grinders; 1 milling cutter and tool grinder; and 1 drill grinder. A vise bench accommodating 70 midshipmen is also available.

Coppersmith Shop.—A shop of good capacity and well equipped is available.

Foundry.—This is in progress of considerable expansion, and will have a small cupola, complete with blower, elevator to charging door; core oven; cranes; crane ladles; brass furnaces, etc. Oil fuel is used for the brass furnaces.

Forge.—This is supplied with 28 forges, with necessary outfit; a steam hammer; and an oil annealing and hardening furnace.

Boiler Shop.—This is equipped with a Ward round boiler, and with two small units of the typical water-tube boilers of the United States Navy.

McAboy, Photo.

MACHINE SHOP—GROUP SYSTEM, ELECTRIC DRIVE

These are used for boiler-test instruction and to drive so much of the general steam engineering plant as is not motor driven. This shop is fitted as a building and repair shop for instruction in construction and repair of all types of shell and water-tube boilers.

Mould Loft.—A large room has been laid off for practical instruction in mould-loft work.

Drawing Room.—A large, well equipped drawing room is provided.

Electrical Equipment.—A three-wire system of lighting and power mains is installed, with accessories, and is used for purposes of instruction.

Work Afloat during Academy Year.—A number of modern ships of different types are maintained at the Academy for this work. The details in regard to it are given in later paragraphs of this Appendix.

Work Afloat during Practice Cruises.—In the summer the first, second, and third classes go aboard ships of all types, from battleships down, for three months in each year. The details in regard to this work are given in later paragraphs of this Appendix.

DEPARTMENT OF MARINE ENGINEERING AND NAVAL CONSTRUCTION.

Instruction for Summer Drill, June, 1905.

Fourth Class.

This commences with all the new midshipmen as soon as they report at the Academy after appointment and continues all summer.

There will be two divisions of the fourth class sent daily to the *Santee's* wharf (except Wednesdays and Saturdays), at 3 p. m. Drill period, 3 to 5 p. m., for steam launch work.

At first all parts of the boiler and machinery will be explained to the midshipmen as briefly as is consistent with thoroughness. The midshipmen are not to stand around, but to take hold and learn different parts,—the boilers and its appurtenances, grate, tubes, furnace, ash-pit, uptake, steam jet, whistle, steam pressure to be carried, the steam gage and valve, fire tools, bottom blow, check valve, how to put water into the boiler, how to empty the boiler, safety valve, boiler stop valve, and water-gage glasses and cocks.

Explain how to start and stop the engine, the cylinder drain to clear off water before starting, working link back and forth for the same, steam pipe from boiler to engine, ditto from H. P. to L. P., exhaust from L. P. to keel condenser, from condenser to air pump, thence to boiler through feed pump and check valve.

Piston rod, crosshead, connecting rod, brasses, crank pin, crank shaft, propeller shaft, thrust bearing, propeller, main bearing, eccentric,—what used for.

Slide valve, vacuum gage,—what used for; oiling, midshipmen to oil, and to know every part needing oil.

Feed pump, all its connections, how to start and stop, how to get water in boiler, danger of low water, what to do in case of low water. Explain the necessity of acting promptly. Drain cocks on feed pump. Little troubles that may arise in getting pump to act and get water into boiler. Connection from pump to feed tank, and from delivery side to check valve, the piping in bilge, and the hand pump to free bilge of water. Make midshipmen know perfectly the connecting pipes and valves between water tanks and to the feed pumps and explain if they fail to get water, to get down and see that communication is open between tanks and pump.

Little casualties that may occur, a water glass breaking, etc.

As soon as all midshipmen are present prepare to start fires, get water in feed tank and in boiler, get coal on board. Midshipmen to prime and start fires themselves. Do it thoroughly. Midshipmen to run the engine

and do the firing. Each midshipman to take turns in duties in firing and in running the engine.

If they cannot maintain steam, show them where the fault lies. See that the midshipmen running the fires attend to their duties in firing and maintaining steam. Go over all parts of engine and boiler while steam is forming.

Midshipman at the throttle to watch his steam gage, regulate steam accordingly, and when steam falls or rises to the using point, to notify the midshipmen at the fires, so that doors may be manipulated or the fires worked accordingly.

Finally, have midshipmen so familiarize themselves with the machinery and its possibilities as to become able to run these boats.

Especial attention is to be paid to the *Naval Academy* regulations concerning conduct of midshipmen on drills, at recitations, etc. Instructors *must report all infractions* of *regulations, indifference, neglect, inattention*, or *any infraction of discipline.*

Keep track of midshipmen who show aptitude and who can be trusted with a boat, so that when requests are later made for the use of a boat competent midshipmen may be designated.

Commence at once and discountenance any slovenliness in the boats. This should be impressed on the new comer early.

The custom of towing a boat into the landing immediately her machinery is disabled to a slight degree is to be discontinued. Subject to the judgment of the commissioned officer in charge of the boat, put a tender alongside and a warrant machinist, ascertain the difficulty. If it can be overhauled and put in shape again soon, have it done; if not, tow the boat in, leave a warrant machinist in charge with the midshipmen, disconnect the defective parts, and the midshipmen, by close contact, ascertain the cause and possible remedy.

Mere engine driving, opening a throttle, or pushing a button is not the main object of this drill. The ability to know what to do and how to prevent casualties is one of the principal objects sought for.

After the midshipmen have obtained the preliminary training, instruct the midshipmen in the equipment of the boat for distant service. Examine them from time to time on this subject and if they do not know after having been taught, report them on the delinquency report for inattention.

As these matters are important in the future study of engineering in this department, instructors will give close attention to the preceding notes.

Midshipmen will take their drawing instruments and for one week; they will be given the preliminary instruction formerly given at the commencement of the term, viz., unpacking and sorting and repacking their instruments, at the same time reading their little pamphlet showing them how to do it, the use of the instruments, and in fact the rough elementary work that we have been using a week of the regular term to accomplish. In this matter carry out at the beginning all our drawing room regulations regarding discipline, conduct, disorder, etc. This is an emphatic order.

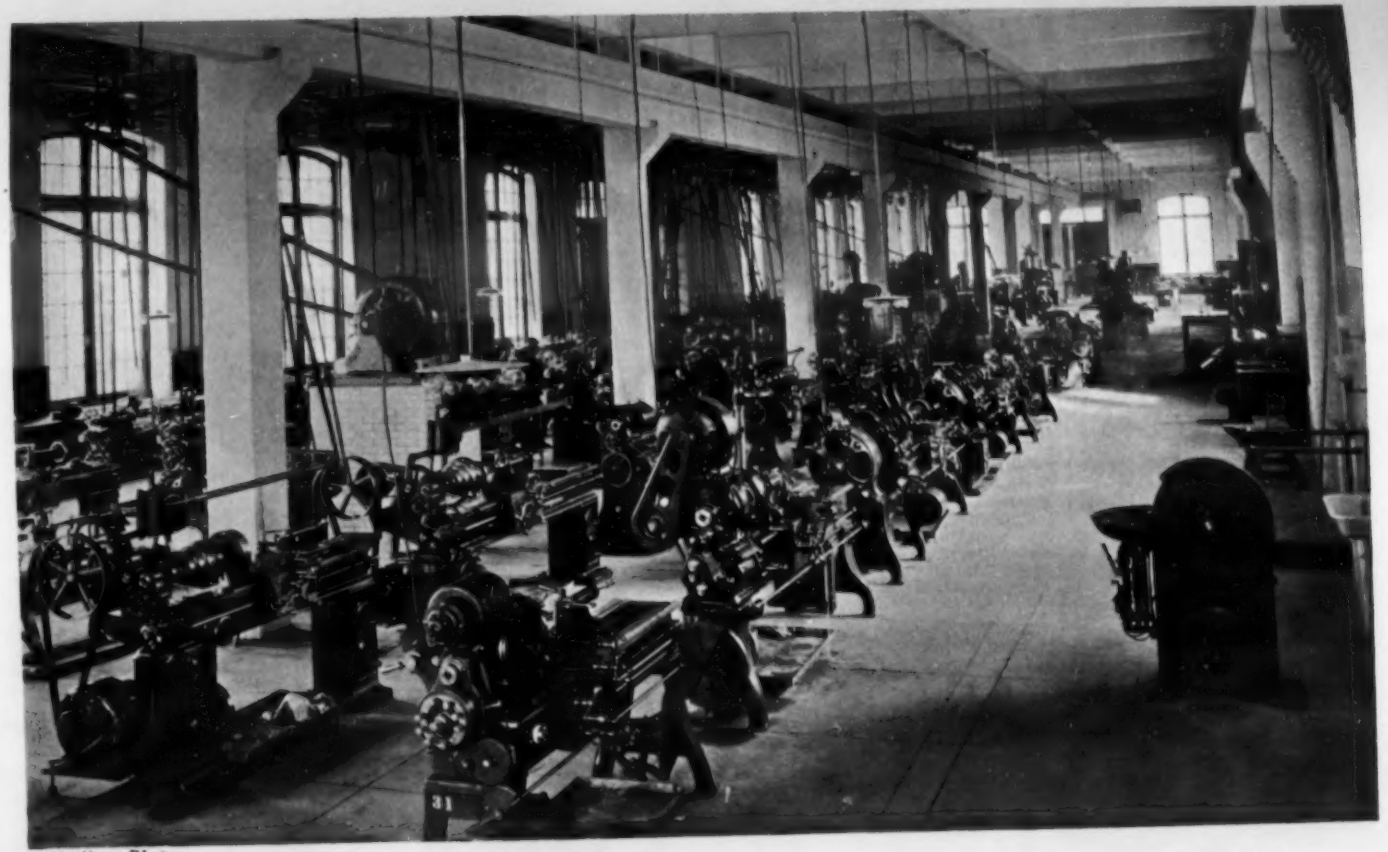
Commence using the miniature log books. Report to the head of the department any difficulty met with in carrying out the above routine.

DEPARTMENT ENGINEERING.

Practice Cruise, Routine.

I.

A detail of first and second classmen will be made for watch standing in the Engineer Department.



McAboy, Photo.

INDIVIDUAL ELECTRIC DRIVE

GROUP OF MACHINE TOOLS

MACHINE SHOP

Detail.—Two first classmen and two second classmen in each watch; number of watches, four (4).

Watch at Sea.—Day and night regular four-hour watches.

Watch at Port.—Four-hour watches from all hands until evening quarters.

II.

Duties of the Watch.—One first classman and one second classman will be put on duty in the fire rooms during the watch as understudys to the water-tender and learning his practical duties. They will manipulate the necessary valves as far as, and as often as, possible, so that they may become familiar with them; watch the water-tender's management of the fires and become able to distinguish between good firing and bad firing, and closely watch the efforts to get the best work from the fuel in handling the fires. They will familiarize themselves with the main and auxiliary feed pumps and connections and in general get acquainted with the fire-room management and discipline.

Engine Room.—The two midshipmen will be understudys of the warrant machinist of the watch and closely follow him up in the execution of the duties of his watch. These midshipmen will handle the machinery under the guidance of the machinist of the watch as much as possible. For instance, if a pump is to be started or stopped, the midshipmen will do it. They will vary the point of cutting off on the different cylinders independently, take cards and notice the effect; vary speed of different auxiliaries and note the result; watch the oiler and note how he attends to his duty and method of examining and oiling the various bearings. They will familiarize themselves with the valves in the manifold boxes and what they connect with. Every midshipman on steaming watches will take a set of indicator cards, work them up for horsepower daily, and insert them in note books after examination by steam instructor. Midshipmen on watch will inspect the evaporating plant during the watch and familiarize themselves with all valves, pumps, etc., in that room, and become able to start, stop, and run the evaporators and distillers. Midshipmen must be able to stop and start all the following auxiliaries:

Ventilating blowers. Forced-draft blowers.
Auxiliary condenser. Fire and bilge pumps.
Main air and circulating pump.
Main feed pump, putting water in boiler from feed tank.
Auxiliary feed pumps, putting water in boiler from tank and overboard from bilge.

A study of the manifold boxes will enable the midshipmen to take the suctions from the different parts of ships with pumps indicated. It is extensive and is not expected to be found out in one or two watches, but with the instruction in the instruction period, the ground can be covered. Attention will be given to the method of writing up the log columns and date that are to be entered.

The details required in the above would be interminably long in a letter, but the above gives an idea of what will be done. Whenever a midshipman can have some responsibility put upon him, it will be given to him in the way of personally looking out for some engine or auxiliary, within limits.

At sea, daily, the officer of the deck will, at least for a few minutes, give each watch of midshipmen a chance to work the engines by bell signals, the midshipmen to work the starting levers and turn the engines, in accordance with signals, themselves, and to notify the fire room regarding the fires.

Instruction Periods.

Utilization of Instruction Periods.—Lecturing to a large number of midshipmen with blue prints will be done as little as possible. Instructor will have the classes divided up into small squads, as introduced in steam drills, on *Stewart, Terror,* and cutters, assign these squads to different parts of machinery and put them right in it, all deck machinery, anchor engine, capstan engine, cranes, and winches, starting pumps, and getting water in the fire main. They will have all the blue prints they desire, but must follow up the details themselves, and thus impress the object sought for in their memory. One problem to one squad will illustrate my meaning.

Squad No. 1.—Three (3) midshipmen. "Trace up the Main and Auxiliary Feed System." This necessitates their getting down to the piping, valves, and pumps, and following it up from the source to eventually the boiler, and it is the practical way of doing the business. All their work will be put in their note books, with line sketches in pencil.

Cover all machinery with squads similar to the above. Instructor to follow up these squads. All the foregoing for the first and second class.

Squads to go in rotation so as to finish up the cycle arranged in their time on board the ship.

Third Class.—The instructor will take this class around all the main and auxiliary machinery, both on deck and below, once a week, and explain the uses and management, etc. This is their first entrance into engineering proper.

The steam instructor will take advantage of any important repairs and overhauling, such as scraping and fitting large brasses and adjusting and setting same, and get as many first classmen as possible to observe it.

Midshipmen on regular watches will mention the important work done in their watches in their note books, with sketches and descriptions of anything like breaks, casualties, and methods of repair.

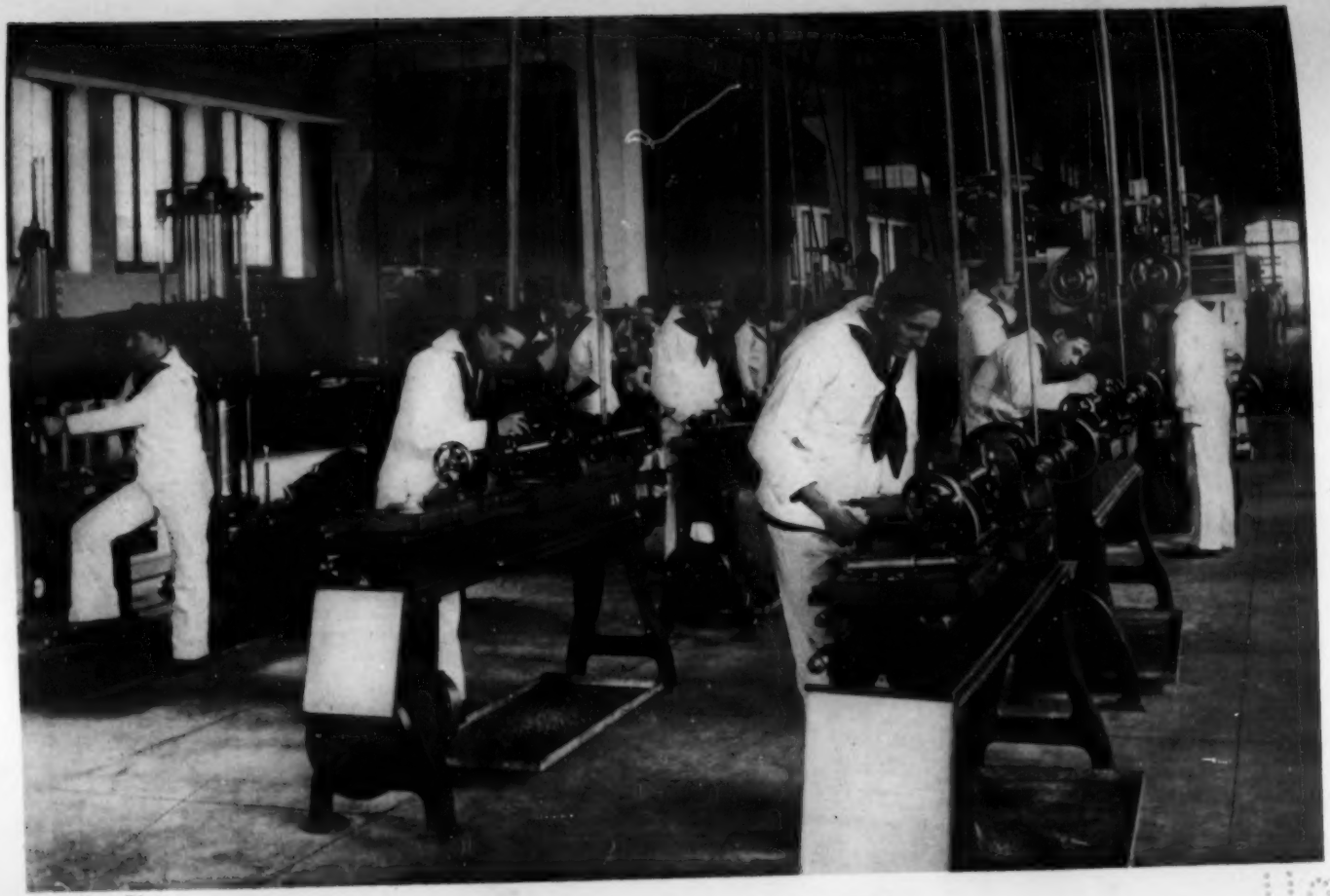
Midshipmen should pay attention to the method of coaling ship, including preparations in the Engineer Department before and after coaling and proper stowage in the bunkers to get the fuel capacity. Any improved methods for rapidity in coaling, improvised or otherwise, for which purpose one or more midshipmen will be detailed with the officer engaged.

Naval Construction.—First class will become familiar with the subdivisions of the ship. Attention will be paid to this subject. They must know the double bottoms, and different compartments. They will make plans in their note books, showing all sea openings, where they are located and where the valve stems can be operated. The drainage system, main and secondary, and how it is operated, must be thoroughly understood. How are the pumps put on any part?

Station Bills.—Examine engineer's general fire and quarter bill, watch bill, and so forth, and learn how to distribute the engineers' complement assigned to a ship, number required at fires, getting out coal, etc., and the engine-room complement.

TABULAR STATEMENT OF PRACTICAL STEAM ENGINEERING WORK OF THREE UPPER CLASSES DURING THE ACADEMIC YEAR.

(See the following tables.)



McAboy, Photo.

PRACTICAL WORK WITH MACHINE TOOLS

NOT IN

PRACTICAL INSTRUCTION: 1904-1905.

Department of Marine Engineering and Naval Construction.

FIRST CLASS.

PRACTICAL INSTRUCTION: 1904-1905.

Department of Marine Engineering and Naval Construction.

WEEK ENDING.	FIRST CLASS.							
	1st Division.		2nd Division.		3rd Division.		4th Division.	
		Cos.		Cos.		Cos.		Cos.
Nov. 12. M. Tu. Th. F. S. . .	Nevada, underway	1-2-3	Machine Shop, Machine tools Experimental work	1-2 3	. . . . .	. . . .	. . . . .	. . . .
" 19. . . . do	Destroyers	1-2-3	Machine Shop, Machine tools Experimental work	1-3 2	. . . . .	. . . .	. . . . .	. . . .
" 26. . . . do	Machine Shop, Machine tools Experimental work	2-3 1	Destroyers	1-2-3	. . . . .	. . . .	. . . . .	. . . .
Dec. 3. . . . do	. . . . .	. . . .	. . . . .	. . . .	Nevada, underway	1-2-3	Machine Shop, Machine tools Experimental work	1-2 3
" 10. . . . do	. . . . .	. . . .	. . . . .	. . . .	Destroyers	1-2-3	Machine Shop, Machine tools Experimental work	1-3 2
" 17. . . . do	. . . . .	. . . .	. . . . .	. . . .	Machine Shop, Machine tools Experimental work	2-3 1	Destroyers	1-2-3
" 24. . . . do	. . . . .	. . . .	. . . . .	. . . .	Machine Shop, Machine tools Experimental work	1-3 2	Nevada, underway	1-2-3
" 31.	. . . . .	. . . .	. . . . . NO DRILLS.		. . . . .	. . . .	. . . . .	. . . .
Jan. 7. Tu. Th. F. S. . . .	Machine Shop, Machine tools Experimental work	1-3 2	Nevada, underway	1-2-3	. . . . .	. . . .	. . . . .	. . . .
" 14. M. Tu. Th. F. S. . .	Machine Shop, Machine tools Experimental work	1-2 3	Nevada Experimental work	2-3 1	. . . . .	. . . .	. . . . .	. . . .
" 21. . . . do	. . . . .	. . . .	. . . . .	. . . .	Machine Shop, Machine tools Experimental work	1-2 3	Nevada Experimental work	2-3 1
" 28.	. . . . .	. . . .	SEMI-ANNUAL EXAMINATIONS—		NO DRILLS.	. . . .	. . . . .	. . . .
Feb. 4.								
" 11.								
" 18.								
" 25.								
Mar. 4.								
" 25.								
Apr. 1.								
" 8.								
May 13.								

Final class is now graduated after semi-annual examinations. Normal conditions would give another four months for instruction.

PRACTICAL INSTRUCTION: 1904-1905.

Department of Marine Engineering and Naval Construction.

WEEK ENDING.	SECOND CLASS.							
	1st Division	Cos.	2nd Division.	Cos.	3rd Division.	Cos.	4th Division.	Cos.
Nov. 12. M. Tu. Th. F. S. . .	Boiler Shop Foundry Copper Shop	1 2 3	Machine Shop, lathes	1-2-3	. . . . .	. . . .	. . . . .	. . . .
" 19. . . . do	Boiler Shop Foundry Copper Shop	2 3 1	. . . . . do	1-2-3	. . . . .	. . . .	. . . . .	. . . .
" 26. . . . do	Boiler Shop Foundry Copper Shop	3 1 2	. . . . . do	1-2-3	. . . . .	. . . .	. . . . .	. . . .
Dec. 3. . . . do	. . . . .	. . . .	. . . . .	. . . .	Destroyers	1-2-3	Machine Shop, lathes	1-2-3
" 10. . . . do	. . . . .	. . . .	. . . . .	. . . .	Boiler Shop Foundry Copper Shop	2 3 1	. . . . . do	1-2-3
" 17. . . . do	. . . . .	. . . .	. . . . .	. . . .	Boiler Shop Foundry Copper Shop	3 1 2	. . . . . do	1-2-3
" 24. . . . do	. . . . .	. . . .	. . . . .	. . . .	Boiler Shop Foundry Copper Shop	1 2 3	Destroyers	1-2-3
" 31.	. . . . .	. . . .	. . . . . NO DRILLS.		. . . . .	. . . .	. . . . .	. . . .
Jan. 7. Tu. Th. F. S. . . .	Machine Shop, lathes	1-2-3	Destroyers	1-2-3	. . . . .	. . . .	. . . . .	. . . .
" 14. M. Tu. Th. F. S. . .	. . . . . do	1-2-3	Boiler Shop Foundry Copper Shop	2 3 1	. . . . .	. . . .	. . . . .	. . . .
" 21. . . . do	. . . . . do	1-2-3	Boiler Shop Foundry Copper Shop	3 1 2	. . . . .	. . . .	. . . . .	. . . .
" 28.	. . . . .	. . . .	SEMI-ANNUAL EXAMINATIONS—NO DRILLS.			. . . .	. . . . .	. . . .
Feb. 4. M. Tu. Th. F. S. . .	Destroyers	1-2-3	Boiler Shop Foundry Copper Shop	1 2 3	. . . . .	. . . .	. . . . .	. . . .
" 11. . . . do	. . . . .	. . . .	. . . . .	. . . .	Machine Shop, lathes	1-2-3	Boiler Shop Foundry Copper Shop	1 2 3
" 18. . . . do	. . . . .	. . . .	. . . . .	. . . .	. . . . . do	1-2-3	Boiler Shop Foundry Copper Shop	2 3 1
" 25. . . . do	. . . . .	. . . .	. . . . .	. . . .	. . . . . do	1-2-3	Boiler Shop Foundry Copper Shop	3 1 2
Mar. 4. M. Tu. W. Th. F. .	. . . . .	. . . .	. . . . .	. . . .	Nevada	1-2-3	Destroyers	1-2-3
" 25. . . . do	Nevada	1-2-3	Destroyers	1-2-3	. . . . .	. . . .	. . . . .	. . . .
Apr. 1. . . . do	Destroyers	1-2-3	Nevada	1-2-3	. . . . .	. . . .	Nevada	1-2-3
" 8. . . . do	. . . . .	. . . .	. . . . .	. . . .	Destroyers	1-2-3	. . . . .	. . . .
May 13. Wednesday . . .	. . . . .	. . . .	ALL DIVISIONS PREPARATION FOR		DRILL FOR BOARD OF VISITORS.		. . . . .	. . . .

PRACTICAL INSTRUCTION: 1904-1905.

Department of Marine Engineering and Naval Construction.

	THIRD CLASS.	
	1st Division	Cos.
Nov. 12. M. Tu. Th. F. S. . .	. . . . .	. . . .
" 19. . . . do	. . . . .	. . . .
" 26. . . . do	. . . . .	. . . .
Dec. 3. . . . do	. . . . .	. . . .
" 10. . . . do	. . . . .	. . . .
" 17. . . . do	. . . . .	. . . .
" 24. . . . do	. . . . .	. . . .
" 31.	. . . . .	. . . .
Jan. 7. Tu. Th. F. S. . . .	. . . . .	. . . .
" 14. M. Tu. Th. F. S. . .	. . . . .	. . . .
" 21. . . . do	. . . . .	. . . .
" 28.	. . . . .	. . . .
Feb. 4. M. Tu. Th. F. S. . .	. . . . .	. . . .
" 11. . . . do	. . . . .	. . . .
" 18. . . . do	. . . . .	. . . .
" 25. . . . do	. . . . .	. . . .
Mar. 4. M. Tu. W. Th. F. .	. . . . .	. . . .
" 25. . . . do	. . . . .	. . . .
Apr. 1. . . . do	. . . . .	. . . .
" 8. . . . do	. . . . .	. . . .
May 13. Wednesday . . .	. . . . .	. . . .

PRACTICAL INSTRUCTION: 1904-1905.

Department of Marine Engineering and Naval Construction.

WEEK ENDING.	THIRD CLASS.			
	1st Division.	2nd Division.	3rd Division.	4th Division.
	Cos.	Cos.	Cos.	Cos.
Nov. 12. M. Tu. Th. F. S. . .	Machine Shop, vise course 1-2-3	Pattern Shop 1-2 Forge 3	. . . . .	. . . . .
" 19. . . . do	. . . . . do 1-2-3	Pattern Shop 1-2 Forge 3	. . . . .	. . . . .
" 26. . . . do	. . . . . do 1-2-3	Pattern Shop 2-3 Forge 1	. . . . .	. . . . .
Dec. 3. . . . do	. . . . .	. . . . .	Machine Shop, vise course 1-2-3	Pattern Shop 1-2 Forge 3
" 10. . . . do	. . . . .	. . . . .	. . . . . do 1-2-3	Pattern Shop 1-2 Forge 3
" 17. . . . do	. . . . .	. . . . .	. . . . . do 1-2-3	Pattern Shop 2-3 Forge 1
" 24. . . . do	. . . . .	. . . . .	. . . . . do 1-2-3	Pattern Shop 2-3 Forge 1
" 31.	. . . . .	. . . . . NO DRILLS.	. . . . .	. . . . .
Jan. 7. Tu. Th. F. S. . . .	Machine Shop, vise course 1-2-3	Pattern Shop 2-3 Forge 1	. . . . .	. . . . .
" 14 M. Tu. Th. F. S. . .	. . . . . do 1-2-3	Pattern Shop 1-3 Forge 2	. . . . .	. . . . .
" 21. . . . do	Pattern Shop 1-2 Forge 3	Machine Shop, vise course 1-2-3	. . . . .	. . . . .
" 28.	. . . . .	SEMI-ANNUAL EXAMINATIONS—	NO DRILLS.	. . . . .
Feb. 4. M. Tu. Th. F. S. . .	Pattern Shop 1-2 Forge 3	Machine Shop, vise course 1-2-3	. . . . .	. . . . .
" 11. . . . do	. . . . .	. . . . .	Machine Shop, vise course 1-2-3	Pattern Shop 1-3 Forge 2
" 18. . . . do	. . . . .	. . . . .	Pattern Shop 1-2 Forge 3	Machine Shop, vise course 1-2-3
" 25. . . . do	. . . . .	. . . . .	Pattern Shop 1-2 Forge 3	. . . . . do 1-2-3
Mar. 4. M. Tu. W. Th. F. .	. . . . .	. . . . .	Pattern Shop 2-3 Forge 1	. . . . . do 1-2-3
" 11. . . . do	Pattern Shop 2-3 Forge 1	Machine Shop, vise course 1-2-3	. . . . .	. . . . .
Apr. 1. . . . do	Pattern Shop 1-3 Forge 2	. . . . . do 1-2-3	. . . . .	. . . . .
" 8. . . . do	. . . . .	. . . . .	Pattern Shop 1-3 Forge 2	Machine Shop, vise course 1-2-3
May 13. Wednesday	. . . . .	ALL DIVISIONS: PREPARATION FOR	DRILL FOR BOARD OF VISITORS.	. . . . .

SYNOPSIS OF PRACTICAL ENGINEERING WORK AT NAVAL ACADEMY, AS SHOWN BY THE PRECEDING TABLES.

(NOTE.—Prepared by Commander J. K. Barton, U. S. N., head of Department of Steam Engineering at the Naval Academy.)

First Class.—On the monitors and torpedo-boat destroyers, midshipmen of first class go out daily in squads and aggregate during the first class year (4 months) 32 hours, and about 8 hours in battleship machinery and auxiliaries in the laboratory. With full standard four-year course this work would be doubled.

Second Class.—Practical work on modern monitors and destroyers; daily for three weeks, aggregating 23 hours. In machine shop, boiler shop, foundry and copper shop, one-half of the brigade comes daily to steam drills during winter months. Their instruction comprises about 47 hours for each midshipman at rate of 1½ hours per day.

Third Class.—Actual work in machine shop at the vise and bench work, 38 hours, forge 16 hours, pattern shop 24 hours; at rate of 1½ hours per day.

Fourth Class.—Two hours per day from July to October 1, each day in the week excepting Wednesdays and Saturdays; total time for summer work, 54 hours per midshipman.

STATEMENT IN REGARD TO PRESENT ENGINEERING WORK AT NAVAL ACADEMY.

(NOTE.—By Commander J. K. Barton, U. S. N., head of Steam Engineering Department at the Academy.)

The course of instruction in the Department of Engineering is illustrated in the annual catalogue. The studies pursued are those which fit the student as quickly as possible and without any of the embroidery usually placed in courses in all of the professions. This has become necessary from the fact that the time is so limited that every thing, except absolutely essential matters, has had to be eliminated. In consequence much of the material that would be found necessary in a liberal engineering education, much that some people would deem theoretical, but still absolutely essential in practice, can not now be taught for want of time. The text-books used are largely the products of U. S. naval officers, many of whom have had a long acquaintance with midshipmen and their methods of study, together with much practical experience afloat and on shore. The books deal with naval engineering matters exclusively and of such parts as the midshipmen and officers of our navy will be brought directly in contact with, that is, the care, maintenance, operation, and preservation of naval machinery.

Practical Drills.

Much attention is paid to this subject in the Department of Engineering from the simple fact that the time allotted is not sufficient to give a man a complete engineering education, particularly since this time has been temporarily cut down by the Navy Department in consequence of the reduction of the course from four (4) years to three and one-half (3½) years. The aim is to familiarize the midshipmen as much as possible with the work they must handle in keeping the machinery of our ships in efficient condition, consequently much work is done afloat. Usually there are two torpedo-boat destroyers at the Academy. These are utilized daily, and advantage taken of their small but high-speed machinery. Midshipmen are given as early as possible, as soon as they are found capable, responsible stations looking out for some practical piece of machinery. As soon as practicable the enlisted men are put on deck, keeping only one

man in the engine room and perhaps one water tender in the fire room, the midshipman being made to run this machinery and being held responsible for their duty. The midshipmen feel this responsibility, and with these high-speed machines there is an element of excitement that appeals to them, and my experience has been that they show great interest in the work.

There is also a modern monitor of the *Nevada* type stationed at the Academy. This vessel also gets away from the dock and makes practice runs. Midshipmen perform the same duties aboard her as they do aboard the destroyers, as both destroyers and monitors are fitted with water-tube boilers. The vessels are started with reduced boiler power and midshipmen raise steam on the idle boilers, and, on the return run, come back with all boilers connected up.

The midshipmen are also exercised in steam cutters. By this time the midshipmen have proven familiar with the machinery of these small boats and can be trusted to handle them properly. I have no fear when they go off for hours by themselves, that the boilers will not be brought back in good condition.

Immediately upon the entrance of the new fourth class, in the early part of July, one-half the class is each day employed in the Engineering Department for two hours in the afternoon. The newly-entered midshipmen are immediately put at the steam cutters. Commencing with brief explanations, they are taught to handle all details for themselves. They are taught everything beginning with the simplest preliminary matter of starting fires and equipping for service, and are exercised at this until every midshipman knows exactly just what to do under all circumstances. They then run the steam cutters, and by the first of October they all seem to be quite proficient in the care and attention necessary to properly operate and take care of the machinery while underway. This elementary study is of vast benefit in their future training and in their class-room instruction in engineering, as many matters, which from a text-book may seen obscure, are rendered much more intelligible by this preliminary experience.

During the winter months, when the certain classes are engaged in running torpedo-boat destroyers and monitors, the others are engaged in indoor drills in the Engineering Building. This building is equipped with the most modern tools, together with all the auxiliaries found aboard our warships. These machines are so equipped that any one can be connected up with compressed air at a moment's notice. The machines are thus run with all bonnets off so as to enable the midshipmen to see every detail of their operation.

Then the midshipmen take apart and reassemble all these auxiliaries until they become very conversant with their construction. This work is done in the model room and laboratories.

In the machine shop, the new and modern foundry, the blacksmith shop, the copper shop, and the boiler shop, the midshipmen in rotation take up courses which give them an idea of the use of all the tools employed in these shops, together with some of the elementary work done in these different branches. A schedule of the time employed is shown in this Appendix.

From an unbiased view of engineering instruction of midshipmen at the Naval Academy, it would appear that any man with the average amount of intelligence and a little aptitude for the subject could enable himself to be made as efficient as he could in any engineering school for the same number of hours alloted to the subject.

It must be borne in mind, however, that no university in the country claims that its graduates are proficient in mining, civil, mechanical, or any other kind of engineering. All such schools claim is that they give to their students the training necessary for success if they will apply what has been taught them and supplement it very largely by experience outside. This, I claim, is being done at the Naval Academy.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

EARLY AMERICAN VISITORS TO JAPAN.

By CHARLES W. STEWART.

The early Americans who visited Japan have received scant notice from writers and historians.

The admirable narrative of Commodore Biddle's visit to Japan in 1846, written by Rear-Admiral Luce, U. S. Navy, and published in the last number of the PROCEEDINGS OF THE NAVAL INSTITUTE, claims that Perry's success in his expedition was in some degree due to the good impressions made upon the Japanese officers, by Biddle's able and tactful manner of conducting negotiations. Biddle is deserving of greater credit and praise. His instructions were positive, in that they commanded him to create no hostile feeling against the Government of the United States. His instructions left it to his discretion, whether he should visit Japan or not. He chose to make the visit to Yeddo Bay, and he performed this duty so amiably and effectively that public opinion in Japan, already favorable to the United States, was increased to that degree which demanded from the rulers of Japan the admission to their harbors of the ships of the United States, a friendly and benevolent nation, grown great through the civil and religious liberty of its people.

The impression prevails in the mind of the average American that Japan was uncovered, if not discovered, to the world solely by the energy and tact of the American prince of men and naval officers, Matthew Calbraith Perry. That noble man deserves and receives the largest credit for his success, yet he profited by the experience, observations, and suggestions of other Americans who had visited Japan before him. It is no disparagement of Perry to say "there were others."

Probably the first citizen of the United States to visit Japan was Major Robert Shaw, who had served in the Continental Army, and in 1797 arrived at Nagasaki in a merchant vessel. He wrote of the cleanliness of the Japanese, their distrust of "hairy devils," their need of American cloths to cover their bodies, and their supply of gold and copper which the people were willing to exchange with merchants.

American ships were employed by the Dutch East India Company to make the annual voyages to Nagasaki in 1799-1803 and 1806-1809. The Boston ship *Franklin*, Thomas Devereux, master, was thus employed in 1799; the Salem ship *Margaret*, Samuel Derby, master, in 1801; and the Boston ship *Eclipse* in 1807.

Commodore David Porter in 1816 proposed the examination of the North Pacific Ocean and the protection of the American sailor and his flag wherever ships could go.

The American ship *Amherst* visited Loo Choo Island in 1832 and relieved a famine by generous distribution of rice and fish.

President Andrew Jackson sent Mr. Edmund Roberts in the U. S. Ship *Peacock* to carry treaty ratifications to Muscat and Siam in 1832, and directed this envoy to attempt to open trade relations with Japan. He died at Canton in 1836 before opportunity offered to go to Japan. Commander David Geisinger, U. S. Navy, of the *Peacock*, having no instructions to continue Robert's mission, made no visit to Japan, but he acquired a knowledge of Japanese character and affairs that enabled him to issue in 1849 admirable instructions to the U. S. Ship *Preble* to rescue from prison at Nagasaki shipwrecked American sailors. Secretary Bancroft gave Biddle authority to continue the duties of the envoy sent out in 1845, thus profiting by the experience acquired in the Roberts' affair.

The voyage of the American ship *Morrison* to Yeddo Bay and Kagosima in 1837 is presented in a volume printed by Charles W. King in 1839. Mr. King was the owner of the ship and the conductor in person of the expedition. His interesting narrative of the voyage, his repulse while endeavoring to land shipwrecked Japanese in their country and obtain trade concessions, furnished the basis for his recommendations to the United States regarding the best means and methods of opening the Japanese oyster. The story of King's successful failure is, in brief, as follows:

Three Japanese survivors of a Japanese junk wrecked at the

mouth of the Columbia River, Oregon, in 1834, were ransomed from Indian slavery by the Hudson Bay Company, and carried via England to Canton and there placed in the charge of the Superintendent of British Commerce in China. Mr. King offered the service of his ship to return the men to their native land. The *Morrison* was stripped of all arms and ordnance and religious papers, and sailed as an American ship to return to their homes the Japanese cast upon American shores by the sea. Four other Japanese, wrecked on Luzon, were placed on board. The *Morrison* sailed from Macao July 3, 1837, with 48 persons on board, anchored in Napa harbor, Loo Choo, July 12, and remained four days. The Loo Chooans asked the Japanese sailors to leave the *Morrison* and return to Kogosima in a native junk, but the Japanese preferred the *Morrison*. Dr. Peter Parker, the physician, in explaining the art of vaccination to a venerable Loo Choo doctor on the shore, successfully inoculated him, to his great alarm and the keen amusement of the natives, many of whom submitted to inoculation. This day, July 15, 1837, is the date of the introduction of vaccination into Japan. The *Morrison* sailed July 16 for Yeddo, the capital city founded in 1458. Mr. King and his companions, including Mrs. King, David Ingersol, master, Dr. Peter Parker, Rev. Charles Gutzlaff, and Mr. S. Wells Williams, naturalist, prepared papers in Chinese to be presented to the Emperor of Japan explaining the nature and purpose of their visit. These papers express, between the lines, something of the opinions of their writers regarding the character of the Japanese.

FIRST PAPER.—The American merchant, King, respectfully addresses His Imperial Majesty on the return of seven of his shipwrecked subjects. He is come to this honorable country from Cap-shoy-moon in China, in a ship of three masts called the *Morrison*, commanded by Captain Ingersoll, having on board a physician and a naturalist.

Three of the shipwrecked men are natives of Ono-oura in the district of Stangoi in the principality of Owari. Their names are Ewa, Kioko, and Oto. They left Owari in November, 1832, in a rice junk for Yeddo and in a tempest lost mast and reckoning, and drifted for fourteen months on the wide ocean without knowing whither they went. Their eleven companions died and they three only remained alive when their junk was thrown on the shore in a country called Columbia belonging to America, and in

part inhabited by savage tribes. Some hunters in that country kindly took care of them and sent them to Heang-Shan-Heen in China. The good people there, remembering the words of Mencius that "he who does not rescue the shipwrecked is worse than a wolf," took care of them until an opportunity might offer for their return to their native country.

The other four are natives of different villages in the island of Kiusiu. They left Amakusa in December, 1834, bound to Nagasaki, lost mast and rudder, and after drifting 35 days were cast on shore in a country called Takar-obo. The people of that country sent them to Heang-Shan-Heen where they met their three countrymen whose shipwreck has been detailed above.

Now, I, seeing the distressed condition of these men have brought them back to their country that they may be restored to their homes and aged parents.

Respectfully submitting this statement, I request that an officer may be sent on board to receive them, to hear the foreign news, to inspect the register of my vessel, to grant supplies and permission to trade. I also request if there be any shipwrecked Americans in your country that they may be given up to me that I may take them home with me on my return.

SECOND PAPER.—*Description of America.*—America lies to the west of your honorable country, distant two months' voyage. Its western parts are not yet cleared, but are still inhabited by savage tribes. On its eastern side, where the people are civilized, and from which we come, it is separated from England and Holland by a wide ocean. Hence it appears that America stands alone and does not border upon any other of the nations known to the Japanese. The population is not great though the country is extensive. Two hundred years ago English, Dutch, and other nations established colonies there. Their descendants gradually increased and sixty-two years ago they chose their first President, named Washington. That high office is now filled by the eighth President. Within the space of sixty-two years America has been twice invaded, but its people have never attacked other countries, nor possessed themselves of foreign territory. The American vessels sail faster than those of other nations, traverse every sea, and inform themselves of whatever passes in every country. If permitted to have intercourse with Japan they will communicate always the latest intelligence.

The laws of America are just and punishment is inflicted only on the guilty. God is worshiped by every man according to his own conscience, and there is perfect toleration of all religions. We, ourselves, worship the God of Peace, respect our superiors, and live in harmony with one another. Our countrymen have not yet visited your honorable country, but only know that in old times the merchants of all nations were admitted to your harbors. Afterwards, having transgressed the laws, they were restricted or expelled. Now we, coming for the first time, and not having done wrong, request permission to carry on a friendly intercourse on the ancient footing.

THIRD PAPER.—*The list of presents* included a portrait of Washington, a telescope, a pair of globes, an encyclopedia, a collection of American treaties, an American history, etc., etc., and a note "that English, though more extensively used than Dutch or Portuguese, may not be understood in your honorable country. If so, and at your request, one of my party shall remain in Japan a year to teach our language."

FOURTH PAPER.—The list of articles on board was closed with a request to trade with the native merchants. Dr. Parker added a note regarding the medicines he had brought with him, stating "the wonderful efficacy of which, as well as the singular skill of their employer, could only be known by experience."

The *Morrison* entered Yeddo Bay July 30. Guns were fired from each shore. Mr. King proposed to anchor at Oura-gawa, but observing the shot striking the water he anchored a mile off the western shore. A boat came alongside. The shipwrecked Japanese were stowed out of sight, that the prepared papers might plead the matter to the imperial power for decision. More than twenty other boats followed and the ship was crowded. The visitors were given cloth, chintze, five-cent pieces, wine, and biscuit. All seemed pleased. Some approved the flavor of the saki. Papers stating that the Americans were friendly were given to the visitors. King considered that his visitors would give a favorable report of their visit on the *Morrison,* and expected the governor of Oura-gawa to come on board. The Japanese told Mr. King, in reply to his query how their officers were distinguished, "If you see a man come on board that trembles very much, he is a mandarin."

During the night a Japanese battery was prepared on a hill, the

nearest point, and about dawn it opened fire on the *Morrison*, without warning of any kind. The *Morrison* got under way and slowly moved out of range. But one shot, out of many fired, struck the ship. None was injured. The shot entered through a port between the fore and main chains, cut three of the deck-planks and rising struck the gunwale of the long boat and passed overboard. Some small gunboats near the battery fired, but their shot did not reach. The *Morrison* sailed out to sea, and after consultation with the Japanese on board, King decided to make another attempt to land them at some unfortified place, preferably Kagosima. A paper was drawn up addressed to the Prince of Satsuma, explaining their visit to Yeddo Bay and the firing of the battery upon an unarmed friendly vessel at Oura-gawa.

The *Morrison* entered Kagosima Bay August 10, 1837, and sent two of the Japanese to some fishing-boats near Miabara. They were carried to the village of Yesaseke, where they told the story of their shipwreck, rescue, and attempted return to Japan. The women and children wept, and one of the native officers was sent on board the *Morrison*. He wore the two swords, and bore on his blue gown the device of a white ring, an inch and a half in diameter, circumscribed about a white square. This figure was supposed to be the arms of the Prince of Satsuma. King gave the paper to this officer, who stated that it should be given to his princely master. At the officer's request he was landed in the *Morrison's* boats with two of the Japanese sailors. The sailors' statements were taken down by a secretary ashore, in order, as they were assured, to be forwarded to the capital. A boatman directed the *Morrison* to anchor near the western shore near the village of Chugemutze, and after anchoring, a boat came from shore and announced that a high officer would visit the ship on the morrow. Only boats bearing officers came to the ship. The crews were fed bread and molasses, which they ate with signs of pleasure.

On the morning of August 12, a boatman warned the *Morrison* that she would better go away. During the day striped cloths were noticed on the hills above the village. The bearing of individuals was such as to awaken Mr. King's suspicions, and he had the topsail yards hoisted, with sails furled, and the cable hove short. The Japanese said that the preparations on shore were "no good," and Mr. King made sail. A fire from the masked

battery behind the striped cloths opened, but the shot fell short. As the *Morrison* neared the village first visited, she was fired on from there. This deeply grieved the Japanese on board, for the firing was at them, and that too after they had received expressions of sympathy from the people. It meant that they were disowned by their country, and left to the sympathy of strangers. As the *Morrison* sailed back and forth across the mouth of the bay she was fired on from one shore then the other. This continued far into the night amid a drenching rain storm. On the following morning the *Morrison* started for Canton. The Japanese shaved their heads in token of final renunciation of their country. The vessel anchored at Macao August 29, and shortly after, October 1, 1837, sailed for the United States with the three American-wrecked Japanese and King's written account of the voyage of the *Morrison*, which was printed in New York in 1839 by E. French.

The better educated of the Japanese were retained at Macao as teachers of their language.

Mr. King proposed that the United States should make a demand upon Japan in view of the insult to the American flag and should present an ultimatum which should embody security for the kind reception of vessels and seamen of both nations in each other's ports; the admission of an American minister to the court of Yeddo; the necessary *exequatur* for such consuls as may be appointed to care for our seamen. The first approach should be above suspicion of mercenary motive, and should be made in the name of humanity. If rejected it should be pressed again with a fine exposition of the injustice of the policy toward Americans, and an exhibition of the defencelessness of Japan in its immense coast-line and exposed capitals; feudal weaknesses; in fact, on the moderation and good-will in our country and others toward Japan. If rejected finally there remains honorable retreat or a choice of two coercive measures. The first was a blockade of the coast of Japan and the turning back of the junks from the north with food supply of rice and fish. This would demonstrate to the Kubo his defencelessness but would bear hard upon innocent people. The second measure proposed was the benevolent occupation of Loo Choo, the *emancipation* of the insular dependencies of Japan from Satsuma to Formosa, aiding them to maintain independence of Japan's control, and the blockade of Kagosima.

Mr. King proposed that the United States consider the case of the *Morrison* as a political question, because no other government could prove its freedom from ecclesiastical motives. King never lost sight of the great object—free commercial intercourse with Japan. It is interesting to read the report of Commodore Perry, dated January 25, 1854, while he was yet uncertain of the result of his visit the previous July. His proposal "to take under surveillance of the American flag upon the ground of reclamation for insults and injuries committed upon American citizens the island of Great Loo Choo, a dependency of the Empire" savors much of King's proposed second coercive measure. Charles W. King died on the steamer *Bentinck*, near Aden, September 27, 1845.

Captain Mercator Cooper of the whaling ship *Manhattan* rescued fifteen shipwrecked Japanese on St. Peter's Island in April, 1846, and carried them and seven others taken from a wrecked junk into Yeddo Bay, where they were landed. Cooper had despatched two passengers cross country to Yeddo several days before he entered the bay, with a message to the authorities explaining the purpose of his visit. The *Manhattan* was towed to anchorage near Yeddo. The passengers returned. The officials at Yeddo met Cooper with some courtesy. Cooper expressed the friendship and good-will of America for Japan, asked for the privilege of trade with her merchants, and received books, charts, water, and food supplies. He sailed after lying four days above Uraga.

Commodore Biddle's visit to Yeddo Bay in 1846 brought forth the following reply in the form of an "Edict" of the Emperor:

TRANSLATION FROM THE JAPANESE EXPLANATORY EDICT.

The object of this communication is to explain the reasons why we refuse to trade with foreigners who come to this country across the ocean for that purpose.

This has been the habit of our nation from time immemorial. In all cases of a similar kind that have occurred, we have positively refused to trade. Foreigners have come to us from various quarters, but have always been received in the same way. In taking this course with regard to you we only pursue our accustomed policy. We can make no distinction between different foreign nations. We treat them all alike; and you, as Americans, must receive the same answer with the rest. It will be of no use

to renew the attempt, as all applications of the kind, however numerous they may be, will be steadily rejected.

We are aware that our customs are, in this respect, different from those of some other countries; but every nation has a right to manage its affairs in its own way.

The trade carried on with the Dutch at Nagasaki is not to be regarded as furnishing a precedent for trade with other foreign nations. The place is one of few inhabitants and very little business; and the whole affair is of no importance.

In conclusion we have to say that the Emperor positively refuses the permission you desire. He earnestly advises you to depart immediately and to consult your own safety by not appearing again upon our coast.

Biddle's visit was lost sight of in the exciting times of the Mexican War. His sickness and death in 1848 prevented him from furnishing a full account of his observations.

It was fully established by the visits of King, Cooper, and Biddle that no purely peaceful application to trade with Japan could be successful. Commodore Geisinger, U. S. Navy, on January 31, 1849, ordered Commander James Glynn to proceed with the U. S. Ship *Preble* to Nagasaki and demand the release of fifteen imprisoned seamen from the United States whaling bark *Lagoda,* wrecked near Matsmai June 5, 1848. In case of failure at Nagasaki to secure the release, Glynn was instructed to proceed to Yeddo and there make a like demand. Glynn anchored at Nagasaki April 18, 1849, choosing his own anchorage. He firmly and boldly demanded the release of the prisoners. The thirteen survivors were delivered to the *Preble* April 26, through Mr. Levyssohn, agent for the Dutch factory at Decima. An adventurous American, with the rollicking name of Ronald MacDonald, was also delivered to Glynn. The *Lagoda's* men told a story of harsh and cruel treatment and the infliction of unnecessary punishments. In many points their testimony does not agree with the statement of the Japanese authorities. This statement bears internal evidence of accuracy. It is probable that their life in the prison house at Nagasaki was more comfortable than life at sea in a loaded whaler making the long voyage to New Bedford.

The foregoing Ronald MacDonald testified to the following experiences:

U. S. S. PREBLE.

Before me, James Glynn, commanding the United States Ship *Preble,* personally appeared this thirtieth day of April, eighteen

hundred and forty-nine, Ronald MacDonald, who being duly sworn, deposes as follows:

I was born in Astoria, Oregon. I am now twenty-four years of age. I shipped at Sag Harbor in the whale ship *Plymouth*, Captain Edwards, on a whaling voyage, on second day of December, eighteen hundred and forty-five.

Being off the island of Japan, I left the ship at my own desire, agreeably to a previous understanding with the captain, he was to furnish me with a boat, etc., and drop me off the coast of Japan, under favorable circumstances for reaching the shore.

Ronald MacDonald further deposes: That on the twenty-eighth day of June, eighteen hundred and forty-eight, after losing sight of the *Plymouth*, I hauled on the wind, standing to the northward and eastward for the land. In entering a bay, I observed some rocks ahead. I endeavored to tack but failed. I then wore to the southward and westward, just clearing the rocks. I kept on the wind until I cleared them. I then ran free to the northward and westward, standing for the opposite side of the bay. I passed through a channel in the reef, and anchored under a shelter, where I tried my pistols by shooting a sea-lion. I then got underway, and stood for the bottom of the bay, where I landed, having understood from the captain that it was inhabited. But finding no inhabitants, I made an experiment of a premeditated design, which, was to see if I could capsize my boat, and right her again. In this I succeeded to my satisfaction. I then ascended the heights to take another look at the ship with a view to lengthening my absence from the ship; I remained two nights in this bay. In the meantime I made an excursion into the interior, but saw nothing of interest.

That, knowing there were inhabitants on the island of Timoshee (or Dessey of the Japanese), about ten miles distant, I put to sea on the third day to go there, with the view of representing myself as destitute.

That, between the two islands, about 10 o'clock in the morning, I turned out the reef in my sail, capsizing my boat intentionally, making no effort to save anything but my chest, which I wanted for ballast and for trimming my boat. My rudder was let go also. Unstepped my mast, righted my boat, restepped my mast, set my sail, and stood towards the lands. I saw a vessel that day about 6 p. m. to the northward. That night I spent in the boat, lying off and on. Next morning early I approached the land and was becalmed. I first discovered smoke, and when day broke, saw some natives launching a boat. They came towards me, within a hundred yards; on my beckoning they approached me timidly, and I jumped into their boat, fastening the painter of my boat to theirs, and made signs to go ashore.

On landing they took hold of my wrists, one on each side, in a gentle manner, put sandals on my feet, and led me to a house.

Here a breakfast was provided for me in their best manner, and they also gave me dry clothes. I remained in this house eight days, when four Matsmai officers arrived from Soya. These officers took me to the capital of the island, situated on the seashore to the northward and westward. There I was imprisoned. At first my apartment was quite small, but on my remonstrating they enlarged it by removing the partitions. After remaining here thirty days, an officer arrived and took me to a town called Soya, on the island of Yesso, distant about twenty-five miles. I was placed in prison in Soya, and remained there about fifteen days, waiting for a junk, which I was secretly told, they expected from Matsmai. This vessel not arriving, I was placed in a small boat, and after a day's journey met a junk and was taken back to Soya, where I was delayed four or five days longer; after which I was put on board this junk and sent to Matsmai. On the passage stopped to get wood and water. On board this vessel I was permitted to go about abaft the mast. I arrived at Matsmai after a passage of fifteen days, on the sixth day of September. Here they put me in confinement, where I remained until the first of October. Whilst here I learned that I had been preceded by fifteen other Americans, who had made attempts to escape. Here they gave me a suit of Japanese clothing and gave me sweetmeats and in all other respects treated me kindly. I was given a rude spoon which had been manufactured and left by one of the party of fifteen Americans who had been imprisoned here before me. On the first of October, I left in another junk for Nagasaki; arrived at Nagasaki on the fifteenth; remained on board two days and landed on the seventeenth.

I was taken in the first place to a small enclosure adjoining the town hall. Here I was met by an interpreter (Morreama Einaska) who told me that in front of the first door of the town house I would see an image, and to put my foot on it, telling me that this image was the "devil of Japan." In passing the door I put my foot on it, but was not able to see it clearly in consequence of the crowd, who pressed me forward. It appeared to be a metallic plate of about a foot in diameter, on which I thought I could see the representation of the Virgin and infant Savior. In the town house I was requested to kneel, after the Japanese fashion, upon a mat. I attempted one knee but they insisted upon my getting down on both knees, which I finally assented to. Soon after this I heard a *hissing* noise and was told by the interpreter that the governor was coming, and that I must make "compliments to him," which was to bend low and not look up. I made a low bow to the governor, though not before I had taken a look at him.

The Japanese inquired my name, my place of birth and port from whence I sailed, and my place of residence. I answered them Oregon, New York, and Canada, with the hope that in the event of an American or English vessel arriving here, either of

them would take an interest in me and that I might be restored to my own liberty, and for the opportunity of giving information to the people of the United States, that some of their countrymen were imprisoned in Japan, and in all probability would remain in prison for life. They then inquired the name of the ship I had left, the name of her captain, and my reasons or motives for leaving the ship. I told them that I had some difficulty with the captain. They finally asked me, "If I believed there was a God in Heaven?" I answered, yes; that I believed in the Father, Son, and Holy Ghost, and in our Lord and Savior, Jesus Christ. I was then told I had permission to leave the hall, and I was then taken in a *cago*, attended by a number of soldiers, to my prison, which I was told was a sort of temple or priest's house. I remained in this prison up to the present time. During this time I was taken to the town hall twice, and also questioned on several occasions, at my prison. The day after being put in this prison, I asked for my books, particularly my Bible. The interpreter told me, with a good deal of fervor or interest, not to speak of the Bible in Japan; it was not a good book. During these interviews, the object of their questions appeared to be to ascertain if I had any influential friends at home who would seek for me; if I had they would send me away; if I had none then they would imprison me for life in Japan.

About the seventeenth of April, I heard signal guns. (About three months before I had been told that when the Dutch ship or any ship appeared approaching the coast, that guns would be fired.) I was told by my guard secretly, that these guns announced the approach of a yearly Dutch ship, and they were also fired to call in the troops from the neighboring towns and districts. On this occasion there were fired six guns, two were in close succession, being repeated at longer intervals. In the hands of the same soldier the next morning, I saw sheets of paper with writing on, which did not appear to be a letter, on inquiring he told me, it was a list of soldiers who had arrived at Nagasaki from some neighboring cities. The number he gave me was "thirty-five hundred and four." I asked how many soldiers there were in Nagasaki on ordinary occasions. He said that the ordinary number was six hundred and fifty, but on this occasion he thought there were about six thousand, besides an unknown number of attendants or followers, an extraordinary force.

On the afternoon of the twenty-fourth, the Chief Serai Tatsnosen, accompanied by the interpreter Morreama Einaska, came to me in my prison and told me that as a new governor and a number of gentlemen had arrived from Yeddo, they had concluded to send me to the Dutch factory. After a while they asked me if I knew the reason of this. I replied, "No"; then they told me that a vessel had arrived from my country. As I had hailed from three different countries, I asked if the ship was from "Oregon,"

that having been assigned as the place of my birth. They said, "No; from New York." I told them that was the place I sailed from. From thence I was taken to the Dutch factory at Decima, and delivered over to the Dutch Superintendent of Trade, where I was kindly treated. The superintendent sent me to the ship. I have heard other cannon fired before the arrival of the *Preble,* which I suppose was a salute on the arrival of the winter fleet of Chinese junks. I was told there was five cannon in Soya, but I never saw any except those I saw on coming from Nagasaki. The troops that I have seen in Japan were clothed in a coat of mail, with hats of paper, Japanned, broad-rimmed, low-crowned, and fitting close to the head. These hats did not appear to be worn for defense. They were armed with two swords, and in addition to these, with bows and arrows, and also with match-locks (the ignited match being carried at the waist). I never saw any mounted cavalry, but heard of such being in the country. The match-locks were with very short breeches to the stock, which was brought against the cheek in firing, as shown to me by one of the soldiers. In firing they kneel on the right knee, throwing the left foot forward, keeping both eyes wide open.

The common people appeared to be amiable and friendly, but the government agents were the reverse.

During my imprisonment I had a number of scholars among the Japanese interpreters, which probably procured me more kindness than I would have otherwise met with. Morreama speaks better English than any of the Japanese I heard attempt it. Two or three of the other interpreters speak a little English. I was told that there was an abundance of mineral coal in Japan, and some not far from Nagasaki.

That I was fully under the impression that the fifteen men, whoever they might be, who had preceded me from Matsmai were still in Japan, and doomed to perpetual imprisonment; and that I believed that their liberation depended entirely upon the success of my efforts to return to civilization, and send them relief.

Upon the arrival of the ship there appeared to be a general excitement among the government agents. On the morning of the twenty-sixth of April, the interpreter came to my prison and exhibited a letter, translated into English, purporting to be a communication to the commanding officer of the *Preble,* requiring him to leave the harbor of Nagasaki on the reception of the fifteen men.

The interpreter wished me to give him the relative rank of the captain of the ship, by counting in the order of succession from the highest chief in the United States. First I gave the people, which they could not comprehend, then the President of the United States, the Secretary of the Navy, commodore, post cap-

tain, and commander. This rank appeared to be sufficiently elevated to excite their surprise.

RONALD MACDONALD.

Sworn and subscribed before me this thirtieth day of April, eighteen hundred and forty-nine.

JAMES GLYNN,
Commanding U. S. Ship *Preble*.

In presence of
SILAS BENT,
Acting Lieutenant, U. S. Navy.
HENRY WILSON,
Purser, U. S. Navy.

When Commander Glynn returned to the United States he had the prestige of being the first man who had induced the Japanese to yield to the demand of foreigners. The interest aroused in his narrative, and the publication in August, 1850, of a full account of his visit greatly aroused public interest regarding Japan, which crystallized into the Perry Expedition.

It is probable that public opinion in Japan condemned the harsh treatment accorded the benevolent expeditions of Americans to her harbors. The educated Japanese viewed the United States as a nation made great by liberty. The charity of the Americans was acknowledged. "Have you any shipwrecked Japanese on board" was among the first questions asked by the Japanese when an American vessel appeared. Her ships' visits were increasing in frequency. Her increasing importunity indicated her purpose to secure substantial recognition. She was the favored applicant for Japan's friendship. This favorable public opinion existed when Perry steamed into Yeddo Bay, and our good reputation, diplomacy, and great guns secured the written agreement of Kanagawa that marked the beginning of Japan's intercourse with the world. This happy result is due in great measure to the early Americans who visited Japan from 1797 to 1849.

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A NEW METHOD IN NAUTICAL ASTRONOMY.

By H. B. GOODWIN.

Amongst the many new features which distinguish present-day processes of navigation from those practiced half, or even a quarter of a century since, few are more remarkable than the manner in which the observation for latitude "near the meridian" has ousted the old-fashioned "meridian altitude" which was formerly almost the only method in general use.

Much valuable time formerly spent by a navigating officer in hovering about the bridge, sextant in hand, waiting for the sun or other heavenly body to visibly "dip," is now saved. The observer simply notes an altitude at any time within a few degrees of azimuth of the meridian, goes to his table for the corrections necessary to convert the zenith distance observed into meridian zenith distance, and latitude is readily found in a minute or two without the interposition of a single logarithm.

Except that the labor involved in the construction of the necessary tables is a little greater, there seems no particular reason why a principle which has been found so advantageous for latitude observations should not be extended to time observations for longitude also, at all events so far as the fixed stars are concerned; such observations of course being made in the vicinity of the prime vertical, just as observations for latitude are restricted to the neighborhood of the meridian. In the application of such a method it will be necessary to tabulate the hour angles and zenith distances of the selected stars when upon the prime vertical. Such tables have been prepared, and will shortly be published by the present writer, for those stars of the first and second magnitudes as have suitable declinations, that is declinations of from 5° to 30°. Of these there are eighteen in all, eleven north and seven south of the equator.

The latitudes proceed by differences of 20′ up to 60°, so that a computer, making use of one or other of the Sumner processes will always find results given for a latitude not more than 10′ distant from the latitude by account. No interpolation for latitude will therefore be required.

To explain the principle of the method let us suppose that at a given instant the zenith distance of a body which is near the prime vertical to the westward is z_0. Then to find the zenith distance z, after an interval of t minutes, we have by Taylor's theorem

$$z = z_0 + \frac{dz}{dt}(15t) + \tfrac{1}{2}\frac{d^2z}{dt^2}(15t)^2 + \tfrac{1}{6}\frac{d^3z}{dt^3}(15t)^3 + \ldots$$

It may be shown that

$$\frac{dz}{dt} = \cos l \sin \mathrm{Az} = \cos l, \text{ if the bearing is nearly } 90°.$$

Similarly it may be deduced that

$$\frac{d^2z}{dt^2} = \frac{\cos \mathrm{Az} \,.\, \cos \text{Angle of Position} \,.\, \cos l \,.\, \cos d}{\sin z}.$$

This expression vanishes if either the azimuth, or the "Angle of Position," that is, the angle at the body between the circles of declination and altitude, is nearly a right angle.

Thus, neglecting subsequent terms of the series, we have in the neighborhood of the prime vertical

$$(z - z_0) = 15 \cos l \,.\, t.$$

So that under this condition, of an azimuth nearly 90°, a heavenly body may be regarded as moving in altitude with a uniform velocity, the value of which is 15 cos l minutes of arc per minute of time.

So that if we know the hour angle at transit over prime vertical, we may find the hour angle corresponding to an altitude observed somewhat earlier or later by a process similar to that employed in correcting an element taken from the Nautical Almanac.

This process, it may be observed, will give results within 1′ of arc, or four seconds of time, up to an hour angle of thirty minutes from the prime vertical in all latitudes to 60°. At 45° of latitude the limit is increased to thirty-five minutes, at 35° to forty minutes, and at 15° to upwards of one hour, for the same limit of error.

A word should be added as to the effect of variations in declination on the part of the tabulated stars. Both the hour angles and zenith distances on prime vertical will clearly be affected by

these variations, and in low latitudes the resulting changes of value assume considerable proportions. If therefore it were necessary to correct separately the tabulated hour angle and zenith distance for a change of declination the additional trouble introduced would greatly discount the value of the tables as a labor-saving device. It has, however, been found possible to combine the two corrections in a single term, so that keeping fast the value of the zenith distance, we have to apply a correction to the hour angle alone. This correction is always small in value, never more than seven seconds per 1′ change of declination, and may, therefore, be readily calculated mentally and applied at sight. Nor does any trouble arise from discrimination in the sign. For we have the general rule

Increased declination *add*,
Decreased declination *subtract*.

The mode of using the tables for observations within half an hour of prime vertical will easily appear from the practical example which follows.

In latitude 55° S., the zenith distance of Antares (declination 26° 15′ S.) was 60° 12′ (west). Required the hour angle.

EXTRACT FROM TABLE.

Antares. Tabulated declination 26° 13′ S.

Latitude.	Hour Angle on Prime Vertical.	Correction per 1′ of Declination.	Zenith Distance on Prime Vertical.	Rate of change of Hour Angle per change of degree in Zenith Distance.
	h m s	s		s
55°	4 39 19	5.4	57° 22′	418.6

Zenith distance (observed)	60°	12′	
Zenith distance (tabulated)	57	22	
Difference	2	50	

Correction $= 418.6 \times 2.833 = 1186^{s} = 19^{m}\ 46^{s}$.

	h	m	s
Hour angle (from table)	4	39	19
Correction for 2′ of declination			11
Sum	4	39	30
Correction		19	46
Hour angle	4	59	16

Logarithmic calculation gives the value as 4h. 59 m. 17.7s.

The above result has been arrived at by neglecting all terms of the series after the third, which, as has been already remarked, can be done in all latitudes up to an hour angle thirty minutes or so distant from that of the transit over prime vertical. When the observation is outside this limit it becomes necessary to take into account the fourth term, viz.,

$$\tfrac{1}{6}\frac{d^3z}{dt^3}(15t)^3.$$

Near the prime vertical this expression reduces to

$$-\tfrac{1}{6}\sin^3 1'\sin C.\cos^3 C(15t)^3$$

where C is the colatitude of place.

The results of this formula are easily tabulated in the form of a correction (in seconds of time) to be applied to the approximate hour angle obtained as before.

When this second correction is taken into account, the range in hour angle for which the tabular method may be applied without appreciable error is extended from thirty minutes to upwards of an hour on each side of prime vertical, whatever the latitude may be up to 60°. Near the equator the range is extended almost indefinitely.

The following extract from table will show the method of tabulation. Arguments latitude, and minutes of time distant from prime vertical passage.

SECOND CORRECTION (IN SECONDS OF TIME).
(To be added to first correction.)

	Distance in Minutes from Passage of Prime Vertical.														
Latitude	m 20	m 25	m 30	m 35	m 40	m 45	m 50	m 55	m 60	m 65	m 70	m 75	m 80	m 85	m 90
	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s
55°	1	2	4	5	8	12	16	21	28	35	44	53	65	79	93

To illustrate the use of this table let us suppose that in the latitude of 55° S. the zenith distance of the same star Antares (Dec. 26° 15′ S.) is 67° 20′ (west). Required the hour angle.

Zenith distance (observed)	67°	20′
Zenith distance (tabulated)	57	22
Difference	9	58
First correction $= 418^s.6 \times 9.933 = 4172^s =$	69^m	32^s
Second correction (for 70 m.) ..... =		44
Sum	70	16

	h	m	s
Hour angle (from table)	4	39	19
Correction (for 2′ increase of declination)			11
Sum	4	39	30
Sum of corrections	1	10	16
Hour angle	5	49	46

Rigorous logarithmic work gives 5 h. 49 m. 43.2 s., so that in this case, an extreme one so far as latitude is concerned, the method may be applied with an error of less than 1′ of arc at a distance in hour angle of 1 h. 10 m. from the prime vertical, giving a total range of 2 h. 20 m., for observations before and after passage. In lower latitudes the range would be still greater.

As we pass from high latitudes to the tropics the method ceases to be applicable, for the obvious reason that a star does not pass the prime vertical in any latitude lower in value than its declination.

But in such cases the body at some time in forenoon and afternoon passes a point of "maximum azimuth," when the "Angle of Position" is 90°, and the body is moving up temporarily on a vertical circle. Now at this position of maximum azimuth the uniformity of velocity in altitude is even more marked than when the body is passing the prime vertical, but its velocity per minute is now 15′ cos *d*, that is, it is independent of latitude of place, and depends only on the declination of body. Tables of hour angles and zenith distances have, therefore, been calculated for the maximum azimuth of most of the stars tabulated, to render the method more generally available near the equator.

The table which gives the "second correction" will be equally applicable in this case also, the argument of declination of star being substituted for that of latitude of place.

For this position of maximum azimuth no correction for a small change of declination is necessary, as the value of such a correction would be inappreciable.

The conservative tendencies of those who "use the sea" are well known, and it would seem, therefore, to be incumbent on any one who invites the navigator to diverge ever so little from his beaten track to set forth as fully as possible the merits of the pro-

cedure which he recommends. I would ask, therefore, the favor of a little more space to place in contrast some of the points of the proposed "Reduction to Prime Vertical" with similar features of the tables for "Reduction to Meridian," which have found such universal acceptance of late years.

Firstly, as to the localities in which the tables are available.

The ex-meridian tables are chiefly advantageous in more or less inaccessible latitudes. A ship leaving a latitude of 40° or 50° and proceeding southward to the much-frequented seas of the tropics would find the range in hour angle during which the tables are available diminish, day by day, for most of the heavenly bodies. With the prime vertical tables on the other hand the range increases as the latitude diminishes, being greatest in tropical, and least in polar regions.

Next, if we consider a particular body. As a general rule it only passes the meridian above the horizon once in twenty-four hours, so that taking both sides of the meridian into account it is available for observation for latitude (so far as the use of tables is concerned) for a period of an hour or so altogether. But every body which passes the prime vertical above the horizon does so twice, and as it has a range of at least two hours on each occasion, we obtain a total of four hours during which the tables may be turned to account, quite a considerable proportion of the whole of its period above the horizon. It follows from this that if we want an observation at a particular time, as during morning or evening twilight, it would hardly ever happen but that a suitable star could be found within the necessary distance of the prime vertical. Generally, two or three such stars are available at the same time.

It should be mentioned in conclusion that the prime vertical tables lend themselves with great facility to the process of calculating altitudes required in the Marcy-Saint-Hilaire Sumner process, the only additional matter necessary being a table of "rate of change of altitude per minute of time," with a small table for the "Second Correction," similar to that given for calculation of hour angle. As in the method of application the process does not differ materially from that of finding hour angle, it is not necessary perhaps to discuss it more fully at present.

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SUBMARINES.

A DESCRIPTION OF TYPES, OPERATIONS OF, AND ACCIDENTS TO SUBMARINES.

By LIEUTENANT J. H. TOMB, U. S. Navy.

Submarines have received so little discussion in comparison with their value, that I am induced to write this article in order to invite criticism and discussion.

There are two main types of submarines, the diving type as typified by the Holland boat, and the even-keel type, as the Lake boat. Each of these two types may be divided into the defensive and offensive. The terms submarines and submersibles have been used to designate the defensive and offensive types respectively and also to designate the diving and even-keel types. This leads to confusion, whereas the divisions given in the first part of this paragraph clearly explain each type.

The diving type necessarily carries very little reserve buoyancy and submerges by pointing the bow down about eight degrees, using the horizontal rudder to keep the bow pointed down. To maintain submergence after arriving at the proper depth, the bow remains pointed down at an angle of about three degrees, though this varies on each craft and a man has to receive special training at the diving rudder.

The even-keel type is fitted with hydroplanes, two on each side and near the center of buoyancy, one hydroplane being forward of this point and the other aft of it. These hydroplanes are operated in unison by hand gear or by an air engine. This type carries more reserve buoyancy, may carry a drop keel, and is considered more easy to handle when submerged.

The defensive type ranges from fifty to one hundred and fifty tons displacement and is built to operate from a base. It may

store its batteries by using its motor as a dynamo or by receiving a current from the base.

The offensive type is above 200 tons displacement and is built to cruise with a squadron, receiving gasoline from a parent ship and restoring its own batteries.

With these various types of submarines in use in the navies of the world, the United States has had experience with only one type, the diving-defensive submarine. The Holland boat is the best development of the diving type, but Mr. Holland's best efforts are now given to develop that type in Great Britain.

The Lake submarine is an excellent example of the even-keel offensive type, but Mr. Lake is likewise engaged in building these craft for foreign governments. Both of the above types were originally developed in the United States. Several boats of the diving-offensive type are now building for our navy.

The Holland type is built fish-shaped, but round, the greatest diameter being about one-third distant from the bow. Its motive power consists of a single gasoline engine for surface running and a motor for submarine running. The storage battery consists of sixty large cells stowed in tanks inside at the bottom of the boat. The storage battery is so divided as to consist of thirty cells to forward battery and thirty cells to after battery, the cells of each battery joined in series. By the switch-board, these batteries may be thrown in series or parallel. To charge these batteries the motor is used as a dynamo, the gasoline engine supplying the power. By a system of clutches the main shaft is connected to either the motor or gasoline engine. In making landings or getting under way, the motor is used, as the gasoline engine is so connected as to drive the shaft one way only.

The air-compressor is worked by gears off the main shaft, and the air is stored in eight 2000-pound flasks, one 50-pound flask, and one 10-pound flask. The two latter flasks are usually filled from the 2000-pound flasks through reducing valves. The 50-pound flask is used for firing torpedoes, supplying the air impulse, and for blowing the amidship tank. It may be connected up, however, to blow any tank. The 10-pound flask is used for blowing out the tanks when the submarine has arrived at the surface.

The ballast tanks are as follows: forward and after trimming tanks, amidship tank, main ballast tank, and auxiliary ballast tank, the latter in some cases consisting of several small tanks.

Trimming down ready for diving is usually done in smooth water. The ventilators are unshipped, motive power shifted to motor, and conning-tower lid and main hatch closed. While this is being done, the trimming tanks are approximately filled to required extent. The muffler to gas engine is closed to prevent water from entering the gas engine. The amidship tank and main ballast tank are then filled in the order given, having first filled the trimming tanks to the required extent. The trimming tanks are usually filled in boats having tall periscopes so as to put the craft about three degrees down by the head, but this is determined by experience on each craft. As soon as the auxiliary tank has been filled so as to leave the amount of positive buoyancy required, about 400 pounds, the craft is in shape for diving. The main ballast and amidship tanks are then blown clear of water; and, when the craft regains its buoyancy, the conning-tower lid is opened, ventilators shipped, and muffler opened. The craft may then proceed to cruise on the surface, using the gas engine. When it is time to dive, the craft is sealed up again, the amidship and main ballast tanks refilled, and motor started. As the craft gains headway, the diving rudder is put down, helm up, and the craft plunges down. The depth is regulated by the diving rudder, a scale registering the depth. Owing to the resistance of the high periscope and the conning-tower to the passage through the water, the tendency of the craft would be to point up were it not for the fact of its being trimmed down by the head. In case of any accident under water, the amidship tank is blown immediately, the air-pressure of fifty pounds clearing the tank of water in a very few seconds. As the amidship tank is practically the safety tank, it is the first tank filled when preparing to dive and the first tank blown when it is wished to regain the surface of the water.

The Lake boat is cigar-shaped, has the same motive power as the Holland boat, but is twin-screw instead of single-screw. The tank arrangement is practically the same, but the reserve buoyancy is greater in submerging, due to the pull on the hydroplanes. The pitch of the screws is regulated by a mechanism inside the boat to give ahead or astern power to the screws, but this is for the gas engine only, as the motors reverse the same as in the Holland boat. Its air system is practically the same as in the Holland boat, but the air flasks are stowed on top of the main steel hull instead of inside. In addition to the hydroplanes, a horizon-

tal rudder for diving is also rigged, but of course this boat would not maneuver as well as a diving type as the Holland boat. Forward is a diving compartment for leaving the vessel when submerged, working on the same principle as a diving bell. This compartment is not so much a safety compartment as it is for a diving bell for carrying on work at the bottom of harbor entrances in mine fields, etc. As a precaution of safety a five-ton lead keel is secured to the center of the keel, which may be dropped in case of necessity by pulling a lever. Living quarters are provided inside for the crew, but these quarters take up so much space that they could better be dispensed with. A large conning-tower is on top of the hull and through this tower project the omniscope and periscope. All the mechanism for operating the boat is centered in this conning-tower. A water-tight hatch is provided to seal the conning-tower off from the hull of the craft. A superstructure is built on top of the hull, forming a compartment used as the main ballast tank. In this compartment are secured the air and gasoline tanks.

A comparison of the relative merits of each type of submarine would be valuable were we able to obtain such practically, but with the experience our navy has had with the Holland boat and with the supposed merits of the Lake boat, much may be determined.

The Holland boat has only one torpedo tube while the Lake boat has three, two ahead and one astern. This makes it possible to fire all or any of the torpedoes when pointed, while practical experience in the Holland boat has demonstrated that an interval of fifteen minutes is necessary between shots, although an interval of ten minutes was obtained in one instance, I believe.

The Holland boat has a periscope while the Lake boat has both omniscope and periscope, the latter extending through and several feet beyond the former. If the periscope of the Holland boat is shot away the boat is rendered useless for day attack, as a conning-tower attack is impossible at day time. The *Peoria*, in a smooth sea, could pick up the periscope of the *Shark* at 2000 yards, in some instances at a greater distance; and in rough weather, at 1000 yards. In the Lake boat, if the periscope is shot away, the omniscope still remains ready for use. In the Holland boat it is a difficult matter to obtain the psychological moment for firing a torpedo, as the craft has to be pointed, put nearly level,

and at the same time kept beneath the surface at the requisite depth to have the periscope lens just clear of the water. In attempts in November, 1904, with the *Shark*, to fire torpedoes at a target it took a minute and a quarter to fire the torpedo on bringing the periscope to the surface, and even then the torpedoes went wild. The fact that the torpedoes went wild was not the fault of the Holland boat, however, but was due to lack of torpedo practice with these craft. In the Lake boat, the craft is always level, can be kept easily at the required depth by the hydroplanes, and consequently renders it more easy to get pointed for firing.

In case of the craft suddenly sinking, due to a leaky valve or other cause, the Lake boat suddenly obtains five tons positive buoyancy by letting go her lead keel. Much as those in the Holland boats scoff at the danger of diving in their boats, the feeling of safety given by the five-ton keel is an element which tends to dissolve nervousness in the crew in deep-sea work that is bound to be reckoned with. As a matter of fact, the danger in diving in the Holland boat is greatly magnified at large. With a well-trained crew and everything in good condition, there is no danger whatever in diving in the Holland boat. The five-ton keel on the Lake boat acts more as an agent to inspire confidence.

The large conning-tower of the Lake boat is relied on to a large extent to keep the vessel in equilibrium, and consequently this conning-tower has been the cause of much adverse criticism of the Lake boat. There is no more likelihood of this conning-tower filling with water than there is of the main steel hull, as both have the same structural strength.

In its desire to obtain the best type afloat for the navy, the Navy Department has made several attempts to hold competitive trials between these two types of submarines, the builders running their own boats, but so far the department has been unsuccessful. The first attempt was made November 16, 1904, but neither the Holland nor the Lake boat was ready; the Holland Company not even sending a boat to Newport, while the Lake boat *Protector* arrived at Newport with her reversing gear broken, a gale causing the trouble while en route to Newport.

On January 11, 1904, the Navy Trial Board met at Newport to take the *Protector* out for a trial, but the board deemed that a thorough trial was not possible at that time owing to the icy condition of Narragansett Bay. Consequently the trial was post-

poned. On January 16, 1904, the Army Trial Board tested the *Protector* in Narragansett Bay with satisfactory results, but this trial was not the thorough one contemplated by the Navy Trial Board. Later the *Protector* was sold and a new boat, *Simon Lake X*, was built. This boat was not completed in time for trial; and, as the department had already delayed awarding a contract for several boats, a contract for two boats of the offensive type was awarded to the Holland firm about December 21, 1904.

The department made another attempt to have a trial of the Lake boat, giving the Lake Company until May 1, 1905, but this company then moved across the Atlantic for the purpose of building boats for foreign governments. It is indeed a misfortune that the department did not succeed in its efforts, as the Lake boat presents some valuable features which are lacking in the Holland boat.

The following serious accidents have taken place with the submarine boats of the world, but it is also shown that had due care been taken, these accidents would not have happened.

The *Delphin* was trimmed down with conning-tower lid open. Too many men were in the boat and the conning-tower was of a low build. When trimmed down, the wash of a passing steamer entered the conning-tower before the lid could be closed. The extra weight of water sank the boat. Had the conning-tower lid been closed before trimming down, this accident would not have happened.

The recent accident to the *Farfadet* was caused by the conning-tower not being properly closed. An attempt was made to close it properly while the craft had down rudder, with the result that the hatch opened and permitted water to enter, sinking the boat.

The *A-8* was under way with tanks filled to such an extent as to give her only one-third of her normal buoyancy. She suddenly dived and her hatch was not closed in time to prevent water entering. The explosion two hours later while this boat was on the bottom, was probably due to salt water entering the batteries, causing them to gas, forming hydrogen gas among others. The sparking of the switches probably ignited this hydrogen.

The *A-1*, while submerged, was struck on her conning-tower by a large ship, springing the hatch open to such an extent as to permit water to enter. The *A-1* traveled along the whole length of the ship's bottom, and at the end of that time a sufficient quantity of water had entered to sink her.

Several accidents have been due to the explosion of gasoline, but the faults producing this have been remedied to such an extent as to render accidents of this nature improbable in the future.

It is by competition that the greatest progress is made. If we had one of the Lake boats on this coast and one on the west coast to compete against the Holland boats, I am confident that our submarine navy would soon rank among the first in the world instead of holding the fifth or sixth place as it bids fair to do. For harbor defense nothing is superior to the defensive submarine and the offensive submarine will soon rise to be an important factor in battle tactics at sea.

The main features of the even-keel type are superior to those of the diving type; and, seeing this, it is necessary for our navy to develop that type if it wishes to have an efficient and capable submarine navy in the future.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE STADIMETER IN FIRE CONTROL.

By COMMANDER BRADLEY A. FISKE, U. S. Navy.

In order to determine the instrumental accuracy of the stadimeter, I took twenty successive observations with one which had been loaned me by the Ordnance Officer at the New York Yard. The object which I observed had a height of 151½ feet and was 6580 yards distant.

The greatest error was 100 yards.

The average error was 35½ yards.

I adjusted the parallelism of the mirrors very carefully and took the observations very deliberately. In order to hold the instrument steady, I used it while sitting down. The "seeing" was, perhaps, better than the average; but there was a great deal of smoke in the air, and the outline of the lower part of the target was quite dim. Therefore, the observations were taken under conditions no better than often can be obtained at sea in fine weather.

Of course, these observations simply show the accuracy of the instrument *per se* when carefully used. They do not indicate that under all conditions such accuracy could be obtained; but they do indicate that, if accuracy inferior to this is at any time obtained, it is not due to the instrument, but to causes outside the instrument.

Inasmuch as knowledge of the true range in battle is not what is required, but rather the sight-bar range, I beg to point out that, if the stadimeter be set at an estimated mast height, and this setting be changed until the indications become such as to cause the guns to hit the target, then the height at which the stadimeter is set may be called the "virtual mast height"; and it makes not the slightest difference whether this be the correct mast height or not. If, for instance, the stadimeter happened to be set at exactly the real mast height, but the powder and other causes connected with

the gun caused the initial velocity to decrease ten per cent from the initial velocity for which the gun sights were calculated, then the projectiles would fall short by about ten per cent; but, if the stadimeter were then set at a " virtual mast height " ten per cent greater than the real mast height, this would compensate for the decrease in initial velocity, and would cause correct sight-bar ranges to be given by the instrument for all subsequent ranges.

That this plan is practicable is proved by the fact that I used it successfully throughout the Battle of Manila Bay, from an observing station which I had rigged in the foretop of the *Petrel*. Other schemes, so far as I am informed, require the continual correcting of the sight-bar range, higher and lower, at every instant of the battle; whereas, if the " virtual mast height " be once found in the beginning, the ranges given by the stadimeter will be the correct sight-bar ranges throughout all subsequent stages of the battle.

It may be objected that this reasoning practically assumes that the error of the stadimeter is zero. Of course, the error is not zero; but, as it is only 36 yards at 6600 yards with a mast height of 151½ feet, the departure from accuracy is so small as to be negligible for practical purposes. In other words, if the stadimeter, at any time, gives a range which causes the guns to shoot over or short far enough to be spotted, it will be simply because the stadimeter has not been set at the " virtual mast height."

At the Battle of Manila, while I was not able always to tell whether shots went over or short, I could always tell when a shot hit, because I could see the flame of the bursting charge. It would seem, therefore, better to begin with a mast height known to be too small, and increase it gradually, until the flame is seen of the impact of the shells on the ship.

The difficulties of fire control, due to smoke, different indices of powders and different kinds of guns, would be the same with this plan as with any other; and so would be the necessity for calibration of each gun, due to jump and other obscure causes.

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NOTES ON THE USE OF THE GREAT CIRCLE SAILING CHART FOR THE SOLUTION OF PROBLEMS IN NAUTICAL ASTRONOMY.

By Lieut.-Commander Armistead Rust, U. S. Navy.

1. There are a number of problems in Nautical Astronomy which may be conveniently solved with the aid of a Great Circle Sailing Chart.

Problem I.—To identify an unknown star having given the latitude and the longitude of the observer, the Greenwich mean time of observation, and the altitude and azimuth of the star.

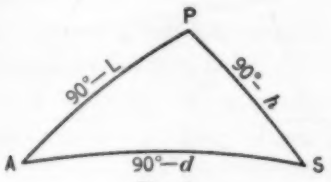


Fig. 1

Reduce the observed altitude and the azimuth to true and find the local sidereal time at ship.

Suppose the problem solved and in the astronomical triangle, *PAS*, Fig. 1, let *P* be the pole, *A*, the zenith of the ship, *S*, the position of the observed star.

Let the triangle be projected on a Great Circle Chart, Fig. 2, where *P* is the pole of the earth, *A*, the position of the ship, *S*, the sub-celestial place of the star, or the point on the surface of the earth where the line joining the star with the center of the earth intersects the surface. Let *EQ* be the equator.

For convenience let *A* be taken as the pole of the spherical triangle *APS* instead of *P*, then the sides

$AP = 90° - L$, where L = latitude.
$AS = 90° - d$, where d = declination.
$PS = 90° - h$, where h = true altitude star.
Angle $PAS = t$ = the hour angle of the star
= the Great Circle Course from A to S.

Angle $APS = Z$, the azimuth of the star = difference of longitude between A and S, and AS = the Great Circle distance, hence the solution of the problem consists in finding the Great Circle Course and the distance between A and S on the Great Circle Chart. Proceed as follows, using the Great Circle Chart of the North Atlantic Ocean: On the meridian of Greenwich, or any convenient meridian, mark the point S in a latitude equal to h, the

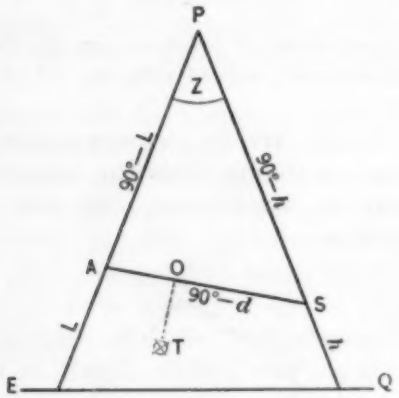


Fig. 2

true altitude of the star. Mark A the position of the ship in latitude, L, and in a longitude from S equal to the true azimuth of the star, Z. Find the Great Circle Course and distance between A and S by the method of the chart. The course is the hour angle of S and the distance is the complement of the declination. We have—

Local sidereal time = R. A. of star ± hour angle of star, hence: Apply the hour angle of the star to the L. S. T. at ship, subtracting when west and adding when east, and the result is the right ascension of the star, and $d = 90° - AS$, and the star may be taken from the Nautical Almanac.

2. In solving problems by this method it is important to so arrange the sides of the triangle that the given angle, or one of the

given angles, will correspond to a difference of longitude on the Great Circle Chart, for it is evident that the Great Circle Course cannot be conveniently laid down on the chart. The parts should be so arranged that the given sides may be laid off as latitudes, as it is not convenient to accurately lay down a known side as a great circle distance, without repeating the process several times, it being not only necessary to find the latitude of the "measuring" line, but also the distance of one point A or S from C the foot of the perpendicular let fall from the point of tangency T on the line AS. This may be done, however, after several trials, quite accurately by using the mid-latitude between A and S as a trial latitude for the "Measuring Line" AS, and then repeating the process once or twice.

3. Example 1. At sea, February 26, 1901, 6.30 p. m., L. M. T., weather overcast and cloudy, observed the altitude of an unknown star, about the second magnitude, through a break in the clouds, 29° 30′ (true), bearing N. 74° W. (true). What is the name of the star? Position by dead reckoning Lat. 35° N., Long. 60° W.

Plotting the zenith of the ship and the position of the star as directed above, in Lat. 35° and 29° 30′, respectively, with a difference of longitude of 74° we find the Great Circle Course to be 72° 30′ = 4 hrs. 50 min., the hour angle of the star, the distance 61° 25′ or declination of star = 28° 35′.

L. M. T.	6 — 30 — 00	R. A. of star 0 — 04 — 16.
R. A. M. S.	22 — 22 — 33	Dec. of star 28° — 35′ N.
Cor. G. M. T.	1 — 43	In the Nautical Almanac these correspond to α Andromedæ
L. S. T.	4 — 54 — 16	(2d mag.).
Star H. A.	4 — 50 — 00	R. A. 0 — 03 — 19.
Star R. A. C.	04 — 16	Dec. 28° 33′ N.

Example 2. At sea, Feb. 26, 1905, about 5.30 p. m., G. M. T., 9 hrs. 40 min., Lat. 35° N., Long. 60° W., by D. R., observed the altitude of a star of 2d mag. through a rift in the clouds, 20° (true), bearing N. 85° 30′ W. (true). Find the star.

As before, we find the hour angle = 5 hrs. 04 min., and declination = 14° 40′ N. Applying the hour angle to the local sidereal time we obtain the right ascension = 23 hrs. 15 secs., and from the star list we find the star must be a Pegasi (Markab).

4. PROBLEM II.—TO FIND THE AZIMUTH OF A KNOWN CELESTIAL BODY AT A GIVEN PLACE AT A GIVEN TIME.

Find the hour angle of the body. Project the astronomical triangle on the chart as before. Mark S on the prime meridian in a latitude equal to the declination of the body, d. Plot A, the position of the observer in latitude, L, and in longitude, t, the hour angle of the body (Fig. 3).

Then the Great Circle Course from A is the azimuth of the body S, and AS is the complement of the altitude. It is evident that we may find the azimuth from the altitude also by describing an arc from S as a center, intersecting the meridian of A, using $90° - h$, reduced to a "measuring line" as a radius. This, however, is not so convenient for the reasons stated in paragraph 2.

Example. At sea, April 28, 1905, Lat. 35° 00′ N., Long. 75° 00′ W., L. A. T., 7 a. m., find the true azimuth of the sun in declination 14° 00′ N.

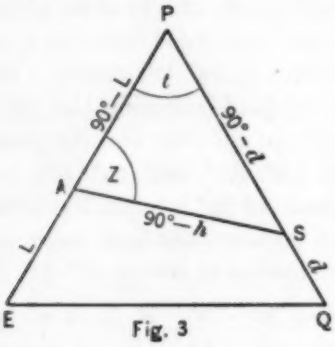


Fig. 3

Following Fig. 3, we find the true azimuth = N. 86° 30′ E.

Other problems may be solved in the same way, for example:

PROBLEM III.—TO FIND THE LATITUDE AT SEA INDEPENDENTLY OF THE LONGITUDE OR TIME.

In Fig. 4, let P be the elevated pole, Z, the zenith of the observer, S, a star west of the meridian PZ, and S', a star east of the meridian.

Let H = the altitude of S.
H' = the altitude of S'.
D' = the declination of S'.
D = the declination of S.

We are required to find PZ = the zenith distance of the pole $= 90° \pm L$ according to whether P is the elevated or depressed pole. We have given PS = polar distance of $S = 90° - D$.

PS' = polar distance of $S' = 90° - D'$.
SZ = zenith distance of $S = 90° - H$.
$S'Z$ = zenith distance of $S' = 90° - H'$.

The angle SPS' = the sum of the hour angles of S and S' when on opposite sides of the meridian PZ, or their difference when on the same side = the difference of the right ascensions of the two stars.

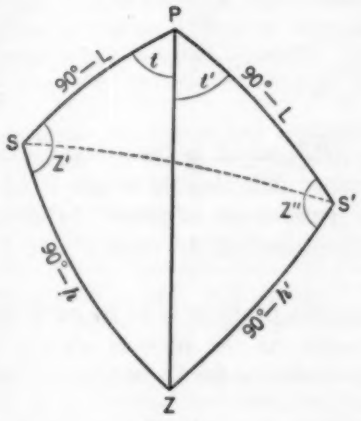


Fig. 4

The solution of this problem is nothing more than finding the Great Circle Course and distance between the points P, S, Z, and S' from the chart in the ordinary way.

In Fig. 5.—With D as a latitude, SPS' = right ascension star S — right ascension star S', as an azimuth, and D' as an altitude, find the angle PSS', and the distance SS'.

In Fig. 6.—In the triangle $SS'Z$, take Z as the pole, then to find the angles Z, ZSS', and $SS'Z$ proceed as shown under problem II, for finding azimuth and hour angle from the altitude, latitude, and declination.

In the triangles PSZ and $PS'Z$ we have

$PS = 90° - D$ $\qquad$ $PS' = 90° - D'$
$SZ = 90° - H$ $\qquad$ $S'Z = 90° - H'$

Angle $PS'Z = PS'S + SS'Z$ and angle $PSZ = PSS' + S'SZ$ (see Fig. 4).

Assuming zeniths at S and S', we have

$SP = 90° - D$ for $90° - L$ $\quad$ $S'P = 90° - D'$ for $90° - L$
$SZ = 90° - H$ for $90° - h$ $\quad$ $S'Z = 90° - H'$ for $90° - h$
$PZ = 90° - L$ for $90° - d$ $\quad$ $PZ = 90° - L$ for $90° - d$

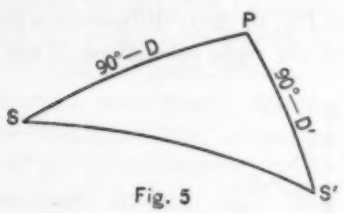


Fig. 5

Fig. 6

Fing the angle SPZ, which is the Great Circle Course from P to Z, and the distance PZ, also the angle $S'PZ$ and the distance PZ again. Now if the work is correct $SPZ + S'PZ =$ the difference of right ascensions of the stars S' and S, a final check on the work.

It is evident that this problem is of no particular value in deep-sea navigation to-day, as the time is always known, and it is inserted merely to show how the Great Circle Chart may be used.

DISCUSSION

THE TRUTH ABOUT NAVAL ADMINISTRATION. (See No. 114.)

Naval Constructor T. G. ROBERTS, U. S. Navy.—Availing myself of the privilege of closing the discussion, I wish to refer to the plan of navy yard consolidation proposed by Admiral Goodrich. To express my ideas more clearly, I will state my view of the effect of his plan in my own language.

He proposes to consolidate workshops and workmen, everything below the commissioned personnel, into one department, leaving five bureaus and five sets of inspectors to run that department. To effect this, an additional civilian from Midvale would be employed as head of the consolidated portion, who would be operated upon in a free for all by the various bureau inspectors who would "naturally make it their aim to see that the work was done promptly, well, and cheaply." By the time Mr. Puddler got through I imagine he wouldn't be found anywhere around the navy yard.

My critic, referring to the head of my proposed industrial department, says: "Does he call upon Midvale, Bethlehem, or Bement, Miles, & Co., for example? Does he summon distinguished members of the Society of Mechanical Engineers, or capable graduates of Troy, Stevens, or Cornell?" *Non, merci.* Not one of those institutions deals in that class of hardware. I beg to offer every assurance that there are shipbuilding firms, societies of naval architects, and universities that teach naval architecture, from which to obtain a qualified person; and if the mere statement be not sufficiently convincing I would be willing to procure documentary evidence and a sufficient number of affidavits to prove that such institutions exist and are available.

PROFESSIONAL NOTES.

Prepared by Professor PHILIP R. ALGER, U. S. Navy.

SHIPS OF WAR, BUDGETS, AND PERSONNEL.

AUSTRIA.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Erzhersog Karl	10,600	Trieste.	Under trial.
Erzhersog Friedrich	10,600	"	Launched April 30, 1904.
Erzhersog Ferdinand-Max	10,600	"	Building.
Armored Cruiser.			
Saint Georg	7,400	Pola.	Under trial.

BRAZIL.

Last year it was announced that the Brazilian Government had drawn up a naval programme, including three battleships, three armored cruisers, six destroyers, twelve torpedo-boats, and three submarines, and that where possible the contracts for these vessels were to be placed with English firms. The announcement is now made that Mr. J. T. Sampson, of Messrs. John Brown & Co., Limited, has been over in Brazil for some months past arranging the designs and contracts for these vessels, and that instead of 13,000 tons, as originally intended, the battleships are to displace 16,000 tons. No definite pronouncement on the subject of the builders of the vessels has yet been made, but it is believed in engineering circles that the contracts will be divided between Elswick, Barrow, Fairfield of Govan, and John Brown, of Clydebank.—*Army and Navy Gazette.*

The Brazilian battleships *Riachuelo* and *Aquidaban* have both had their heavy military masts removed, and single light masts substituted. These ships were originally built at Samuda's yard on the Thames in 1883 and 1885 respectively. They were reconstructed about a decade ago, the *Riachuelo* at La Seyne in 1895, the *Aquidaban* at Stettin in 1897. This latter ship went subsequently to Elswick for new guns. At La Seyne and Stettin they were given tower-like military masts, which almost caricatured the wildest French efforts in this direction, Brazil then being a firm believer in such erections. These masts made them roll a good deal, and also helped unduly to submerge the ships. Now they are better sea boats, and their belts have ceased to be entirely under water.—*Engineer.*

FRANCE.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
République	14,865	Brest.	Under trial.
Démocratie	14,865	"	Launched May 2, 1904.
Patrie	14,865	La Seyne.	Under trial.
Justice	14,865	"	Launched Oct. 27, 1904.
Vérité	14,865	Bordeaux.	Building.
Liberté	14,865	St. Nazaire.	Launched April 19, 1905.

FRANCE.—Continued.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Armored Cruisers.			
Ernest Rénan,.....	13,644	Brest.	Building.
Jules Michelet.....	12,550	Lorient.	Launched Aug. 31, 1905.
Jules Ferry.....	12,550	Cherbourg.	Under trial.
Victor Hugo.....	12,550	Lorient.	" "
Edgar Quinet	13,644	Brest.	Building.
Waldeck Rousseau.....	13,644	Lorient.	"

The French programmes of new construction for next year and the present are as follows:

	1905.	1906.
Battleships		3 (18,000 tons)
Armored cruisers	2 (14,300 tons)	
Destroyers	4 (431 tons)	10 (431 tons)
Torpedo boats.....	20 (100 tons)	
Submarines	8	20

The following ships should be completed in 1906: One battleship—*Republique;* two armored cruisers—*J. Ferry, Victor Hugo;* seven destroyers—*Stylet, Tromblon, Obusier, Mortier, Claymore, Carquois, Trident;* twenty-four torpedo-boats—Nos. 294-317; and fifteen submarines—*Omega* and *Q* 47-60. The *Republique* will have cost £1,462,000; the armored cruisers about £1,200,000 each; the destroyers average £60,000 per boat; the torpedo-boats, which are small, about £6500 each; and the submarines nearly £70,000 per boat.

The new 18,000-ton battleships of the 1906-07 programme are likely to cost nearly £1,700,000 each. They will in general features probably resemble the *Henri IV* greatly enlarged—that ship being steadier in a seaway than any other French vessel. The armor will be of the same thickness as that of the *Republique* class, and the *Republique's* arrangement of artillery is to be followed. The armament is four 12-inch and twelve 9.4-inch, the 12-inch being coupled in the usual fore-and-aft turrets, the 9.4's paired and replacing the paired 6.4's of the *Republique.* In comparison with the *Dreadnought* the new French ships are inferior, the more so as they are unlikely to be completed much before 1911, whereas the *Dreadnought* should be in commission in 1907; but they are superior to the *Lord Nelson* to a slight extent, having an extra intermediate gun on each broadside; 12-pounders, or some corresponding piece, will be adopted as the anti-torpedo-boat gun. The destroyers and submarines of the new programme will follow existing models.—*Engineer.*

The report of M. Charles Bos upon the French navy estimates of 1906 is a document very full of interest. He begins by drawing attention to the crisis in the navy, arising from slowness of promotion, some officers remaining seventeen years in the same rank, while the warrant officers require encouragement, and the navy suffers under the weight of tradition and has establishments which belong to the navy of a former time. Meanwhile the necessity of a strong navy has been once again demonstrated by the war in the Far East, and the preparation of a programme is declared to be absolutely necessary. M. Bos devotes a great deal of attention to the war, and deduces from it the lesson that medium artillery will disappear from warships, and only large guns and those of small caliber be required; also that the hull must have a greater width of armoring above and below, while the steering gear and the internal communications must be protected. Guns are to be coupled in turrets by preference; the superstructures are to be reduced, and also the masts; the smaller guns are to be grouped under the deck in batteries, or protected if they are on the upper

deck; armored gratings are required for the funnels to prevent explosions of shell reaching the stoke-hold; the conning-tower is to be less visible and more solid; the ram and torpedo tubes are to be suppressed; the armoring may be further reduced in thickness, in order that it may more effectually cover the ship; and all ships are to be provided with numerous range-finders and the guns with telescopic sights, so that the gunners may practice at ranges from 3000 to 10,000 meters. Another important point is that the ships are to be protected against the torpedo by a double hull, or at least by numerous watertight compartments. Still another important matter is that M. Bos demands the suppression of the middle screw and the third engine, which are common in French ships, thus economizing in men, money, and weight. As to the guns, M. Bos thinks the 12-inch too heavy, and the 9.4-inch in certain cases and at certain distances insufficient, and he holds that the 10.8-inch gun would be adequate.

We have not space to give all the details of M. Bos' report, but some other points are of interest. He proposes the construction of a type of battleship-cruiser, which would have a double hull, at least in this sense: that vertical armoring would form a kind of second wall to the hull. There would be no torpedo tubes, and the steering stations would be differently placed. The heaviest plating would be of 8.6-inch, and the upper ranges of 7.8-inch, but in order to save weight this upper plating would not extend aft of the battery. The inner wall of the hull, which has been referred to, would be of thin steel. The displacement of the type would be 17,810 tons, and there would be sixteen 10.8-inch, with twelve 2.9-inch and twelve 1.8-inch, all these in batteries protected by about 6 inches of steel. The speed would be 20¼ knots. In relation to the programme, M. Bos recalls the fact that, in order to reach the strength proposed upon the advice of the Superior Council of the Navy, it would be necessary to construct by the year 1919 11 battleships, 10 armored cruisers, 6 second-class armored cruisers, 6 scouts, 66 destroyers, and 90 submarines and submersibles. He shows, however, that, if a proper limit of age be allowed for these classes, it would be necessary to construct 16 battleships and not 11, and a similar proportion of the other class. If, says M. Bos, the programme be carried out, it will mean a replacing of the existing ships unit by unit, and not an increase of strength. He, therefore, says that much more will have to be done, and that the budget committee does not oppose the construction of three battleships to be begun upon the estimates of 1906, but demands fuller details and asks for a trial speed of twenty knots. Except for the torpedo craft, the committee considers the programme inadmissible. It objects to armored cruisers, because they are not proper fighting ships, answering to any necessity, and are ruinous because they cost too much, while the proposed scouts are not sufficiently numerous. Each squadron must have at least five or six scouts. It is recommended that one single type of large vessel should be arrived at, and apparently that proposed by M. Bos is in view. M. Bos also institutes a very interesting contrast between the French and German navies, remarking that, though at first sight the French fleet might seem much superior, the difference arises chiefly from the larger number of small vessels on the French side, while in the matter of big ships the numbers are practically equal, but Germany is gradually drawing ahead in number, homogeneity, and value.—*Army and Navy Gazette.*

LAUNCH OF THE JULES-MICHELET.—The first-class armored cruiser *Jules-Michelet* was launched on the 31st of August from the dockyard at Lorient. Her dimensions are as follows: Length, 489 feet; beam, 70 feet 2 inches; displacement, 12,750 tons, on a mean draft of 26 feet 3 inches. Protection is afforded by a complete armor belt of hard steel, with a thickness of 5.9 inches in the center, and 3.94 inches at the extremities, extending 7 feet 6 inches below the water-line, over a plate thickness of 0.79 inch. Above the belt the armor will have a thickness of 4.9 inches, to a

height of 7.54 feet above the water-line. Forward, this armor will be carried as high as the casemates of the 6.48-inch guns. The two armor decks will start respectively from the top and bottom of the armor belt, and will form with it a caisson divided into a number of water-tight compartments. The armament will consist of two 9.4-inch guns in the fore turret, and two 7.6-inch in the after, the turrets being protected by 8-inch armor, with 5-inch hoists; twelve 6.48-inch guns in casemates; and a number of 2.56-inch and 1.85-inch guns; also five torpedo tubes, two of them submerged. Her three engines of triple expansion will develop a total of 29,000 H. P. She will have 28 Du Temple-Guyot small tube boilers, and four funnels, 69 feet in height. Her speed will be about 22.5 knots. When launched, she was already fitted with her propeller shafts and her false keels, and her upper decks were finished. Her launching weight was 5000 tons, representing 60 per cent of her construction. She was laid down 1st June, 1904, and should be ready for her trials in 1907. Her cost is estimated to be 30.842,731 francs (£1,233,709).

In the case of her sister-ship, the *Jules Ferry*, some modifications were introduced in the designs of the boilers, by which the grate surface was augmented and the coal consumption per square foot of grate surface per hour was reduced from 44.64 lbs. to 38.3 lbs.; in the boilers of the *Jules-Michelet*, the proportion of grate surface to heating surface has been still further reduced, and at the same time, the number of tubes in a boiler has been decreased by one-twentieth, with the result, it is hoped, of reducing the coal consumption to 33.38 lbs. per square foot of grate surface per hour.—*United Service Institution.*

M. LOCKROY (EX-MINISTER OF MARINE) ON THE NEW FRENCH SCHEME OF CONSTRUCTION.—With regard to battleships, M. Lockroy expresses surprise that the tonnage should be restricted to 16,000, while foreign navies will shortly be in possession of 19,000-ton vessels. The speed of the new French ships will be but 18 knots, whereas 19 knots will be attained by Great Britain and Japan.

He questions, too, the wisdom of building armored cruisers, even of the first-class, still more the utility of the second-class cruisers. Of what use are they? he asks. Their protection and armament are too weak to enable them to take their place in line of battle, and if they are to be employed in scouting work, of what avail are their large guns and solid armor belts? Their inclusion in the programme would seem to be a matter of sentiment only, due to the influence of a tradition from which the authorities are unable to shake themselves free.

"We shall find ourselves," he continues, "in possession of a fleet of ships which, after spending hundreds of millions of francs on their construction, we shall not know how to make use of." That is the weak spot in the programme. In place of this undecided sort of policy, which supplies battleships wanting in speed, and cruisers lacking power, he would establish one definite type, at once swift and powerful, which would meet every requirement of naval warfare. Such a type it would be well within the power of the naval architects to design, and he would call upon the most distinguished of their number, such men as M. Laubeuf, the inventor of the submersibles, to supply the necessary plans.

Such a vessel might be expensive, though not so costly as is supposed, but it would justify its expense. For the same amount of money which it is proposed to waste on vessels having no military value, he would undertake to supply a fleet which would be a real credit to France.—*United Service Gazette.*

NEW BATTLESHIPS.—The *France Militaire* discusses the indications which have been made public of the characteristics of the new French battleships. These, it is said, will displace not less than 18,000 tons, which is a surprising increase, since France has so long been content with ships of 11,000 or

12,000 tons. Protection, speed, and range of action will not, it is believed, be greatly modified in comparison with the *Patrie* class, but there will be an armament of four 12-inch and twelve 9.4-inch guns. The *France Militaire* remarks that there has been long hesitation, and that now France is following other countries at a considerable distance. The 9.4-inch gun has an initial velocity of 925 meters, leaving far behind it the older guns. The trajectory is extremely flat, and great precision of fire is possible, with largely increased perforating power. Employing a capped shell, the armor, according to this authority, of the *King Edward VII*, the German *Braunschweig*, and the Japanese *Shikishima* would be perforated.—*Army and Navy Gazette.*

NEW SUBMERSIBLES.—The characteristics of the new French submersibles which have just been laid down at Cherbourg are officially given as follows: Length, 51.12 m.; width, 4.97 m.; draft, 3.12 m.; displacement, 398 tons. Maximum horsepower, 700; steam engines; twin screws; 12 knots speed; 7 torpedo tubes. There are to be 12 of these boats built at Cherbourg, 3 at Rochefort, and 3 at Toulon.

The French submarine *X*, constructed at Cherbourg from the plans of M. Romazotti, has arrived at Brest. The boat is of curious construction, and it was remarked that she floated very low in the water and was scarcely visible. After reaching Brest, for some reason not explained, she returned to Cherbourg. The correspondent of the *Yacht* at that port says that *X*, like *Z*, will not equal the *Aigrette*. She will present very little resistance to the sea owing to lying so low in the water, there being nothing very visible, except a little superstructure, which includes the conning-tower, the ventilators, and the manhole for entering the boat. Abaft of this structure almost everything is under water, except some fixings of the after torpedo tube, and large metallic shields protect the propeller shafts externally. There are four torpedo tubes—one at the bow, two at the sides, which can be projected and withdrawn, and one at the stern, which is capable of a small degree of lateral movement. All the torpedoes are of 17¾-inch diameter. *X* is admirably armed—at least in appearance, says the correspondent—and has a multitude of mechanical appliances. She is described as *un sous-marin dernier cri*, but the correspondent greatly prefers the good submersible *Aigrette*, and even those of the earlier type.

It has been decided that the submarine station, which was to have been established first at Dunkirk and then at Boulogne, will be located at Calais instead. This port is said to be better placed for the use of submarines of short range of action. The correspondent of the *Yacht* describes the choice of the port as very judicious, since it "commands" the Strait of Dover at its narrowest part, and is nearest to our new naval harbor. With half-a-dozen submarines at Calais, the Strait, it is said, will be difficult to pass in the daytime, and in fine weather, and the same flotilla might hinder, or at least render difficult, the bombardment of the two neighboring ports of Dunkirk and Boulogne. This, at least, is the opinion of the correspondent of the *Yacht*.—*Army and Navy Gazette.*

SUBMARINE NAVIGATION PROGRESS IN THE LAST TWENTY YEARS.—A paper by "Max," in *Le Yacht* of October 21, gives an interesting account of what has been done in the construction of submarine and submersible boats during the last twenty years in France and England respectively. In France systematic construction began in 1885 with the *Gymnote*, a small submarine of 31 tons. Since that date boats of no less than sixteen different types have been constructed of very varied displacements, ranging from 30 to 425 tons. During the last year or two a very general agreement seems to have been arrived at that none but the very highest displacements are serviceable, and the 1905 Budget provides for the construction of no less than sixteen of 400 tons.

This large number is, of course, somewhat exceptional, and is due to the

desire of M. Thomson, the Minister of Marine, to make up for the ground lost during the period when M. Pelletan was in office—some two years and a half in all—during which time only two units were added to the strength of the submarine flotilla.

In England the construction of submarines dates only from 1901, when five *Hollands*, of 120 tons, were ordered. In the following year a larger boat of 180 tons, known as the *A*, was added, and in 1902 three more of the *A* class followed, each of 200 tons. The year 1903 saw the introduction of the *B* class, of 300 tons, and the eleven boats of the 1905 programme will bring up the total number of these 300-ton boats to twenty-two.

It is somewhat remarkable, having regard to the very large number of types employed, that the French should have enjoyed such immunity from disaster in comparison with ourselves. Almost the only serious accident that has occurred, moreover—that which involved the loss of the unfortunate *Farfadet*—was clearly traceable to the indiscretion of the officer in command, rather than to any flaw in the plans of the boat itself. Such a result would appear to indicate not only that the principles of submarine construction must be thoroughly understood in France, but also that the boats must have been navigated with a skill and prudence highly creditable to the officers and men employed upon them.—*United Service Gazette.*

NEW SUBMARINES.—It was announced recently that submarines of a new type were to be laid down at Cherbourg, of which the *Emeraud* would be the first, and because of their size they were to be called submarine cruisers. We learn from the *Moniteur de la Flotte* that this information is not quite correct. The boats referred to are not the six submarines of the *Emeraud* type designed by M. Maugas, which are already in hand and should be completed in 1906 and 1907. The new boats are designed by M. Laubeuf, and are eighteen in number, the order to lay them down being dated August 26. Twelve of them are to be built at Cherbourg, *Q* 51 to *Q* 63; three at Rochefort, *Q* 64 to *Q* 66; and three at Toulon, *Q* 67 to *Q* 69. They are to be completed in 1908 or at the beginning of 1909. They will displace 398 tons, being 8 tons more than the *Emeraud* and 97 tons more than the *Omega*. They will be 168 feet long, with 16 feet 4 inches beam, and their engines (steam) will be of 700 H.P., giving a speed of 12 knots. We do not learn anything as to their submerged propulsion. They will have two screws, seven torpedo tubes, and will carry two officers and twenty-two men.—*Army and Navy Gazette.*

THE SUBMARINE AND TORPEDO AND FIXED DEFENCE LOCAL COMMITTEES.—M. Thomson, Minister of Marine, on taking office appointed a Commission to consider the position of the Submarine Committees in each naval port, and of the torpedo and fixed defence sections. On the report of this Committee a decree has now been issued, by which it is ordered that the General Staff of the Navy in Paris will henceforth be charged with the control of all questions relative to the *matériel* of torpedo-boats and projectors, and will issue orders to the permanent experimental committee of submarine defences to be established, relative to the carrying out of all trials and experiments, and the fixing of the needs and requirements of the fleet, ports, and *points d'appui*.

The torpedo flotillas and fixed defences become executive commands, either under the maritime prefect of the arrondissement, or the naval commanders in Corsica, Algeria, etc.

The torpedo schools are placed under the rear-admiral attached to the staff of each port, and the inspector-general of torpedo-flotillas (Admiral Fournier) will also inspect the submarine flotillas and fixed defences.

As regards the technical and administrative services of torpedoes at headquarters, these are now placed under the Direction of Naval Constructions, and the Director of Naval Ordnance; the automobile torpedoes and accessories, such as the Obry apparatus and launching tubes, etc., are also now to be under the department of the Direction of Naval Constructions.

Fixed torpedo mines, etc., are to be under the Naval Ordnance Department; these departments having better means of taking efficient charge of these matters than were possessed by the former submarine committees.

Economy will result from these changes, as the suppression of the five submarine committees in the naval ports will effect a saving of money, and also set free a number of officers for the general service of the fleet.—*United Service Institution.*

ARMORED TORPEDO-BOATS.—Some time ago Messrs. Yarrow produced an armored destroyer—the *Corrientes* class of Argentina. Since then France has devoted some attention to armored torpedo-boats, and some of the old *Division* boats of the German fleet have always had some sort of belt. We now learn that some of the new French destroyers are to be almost completely protected along the water-line with 2-inch hardened steel belts. These belts will render them invulnerable to 6-pounder and 3-pounder guns, and tolerably safe against 12-pounders, except at comparatively short range. As, however, larger pieces than 12-pounders are now coming in for anti-torpedo work, we doubt the wisdom of this armor, which seems likely to do little more than aggravate such hits as are obtainable, as an armored side, when it is penetrated, usually means a more destructive hit than were there no armor at all. On the other hand, the recent war has gone far to indicate that proving-ground penetrations are not likely to be secured in battle.—*Engineer.*

GERMANY.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Lothringen	13,200	Danzic.	Launched May 27, 1904.
Deutschland	13,200	Gaarden.	" Nov. 19, 1904.
O	13,200	Stettin.	" Dec. 2, 1905.
Hanover	13,200	Danzic.	" Sept. 26, 1905.
		(Schichau Works.)	
Q	16,000	Kiel.	Building.
R	16,000	Danzic.	"
Armored Cruisers.			
Roon	9,500	Kiel.	Launched June 27, 1903.
York	9,500	Hamburg.	Under trial.
C	11,500	Bremen.	Building.
D	11,500	Hamburg.	"
Protected Cruisers.			
Lübeck	3,000	Stettin.	Under trial.
Danzic	3,200	Danzic.	Launched Sept. 23, 1905.
Koenigsberg	3,200	Kiel.	Building.
Leipsig	3,200	Bremen.	Launched, Mar. 22, 1905.
O	3,400	Danzic.	Ordered.
Ersatz Wacht	3,400	"	"
" Blitz	3,400	"	"
P	3,400	"	"

NEW BATTLESHIPS AND SUBMARINES.—The first German submarine, which is a boat of 180 tons, was launched at the Germania Yard on August 30, and will soon be undergoing trial. It is understood that the Budget will contain a sum of 2,000,000 marks for the construction of experimental submarines, and we have already stated that Messrs. Körting, of Hanover, are to supply sixteen oil motors of great power intended for submarine navigation. Indications concerning the new battleships to be laid down are to the effect that they will have a displacement of 16,000 tons, and

that their draft will be such that the Kaiser Wilhelm Canal will have to be deepened for their passage. The locks at Holtenau and Brunsbüttel will have to be lengthened from 150 meters to 200 meters, besides being widened, and the works will occupy four years at least. Another indication of the growing naval purposes of Germany, is the decision of the Vulcan Company of Stettin to open a yard with basins and docks on the Elbe, which are to constitute, in case of war, a base for the German squadron in the North Sea, Wilhelmshaven not sufficing altogether for the necessities. These projects arise from the proposals of Admiral Tirpitz, which are expected to be announced in the Reichstag presently.—*Army and Navy Gazette.*

Ueberall gives an account of the new German cruiser *C*, which is in hand at the Weser Yard, Bremen. She displaces 11,500 tons, and therefore greatly surpasses in size her two most recent predecessors, *Roon* and *York*. She is to have a maximum speed of 22.5 knots, with 26,000 horsepower, while her sea speed is to be 21 knots. She will carry eight 8.2-inch guns, four of them in turrets and four of them in casemates, and six 5.9-inch with 23.4, and some other secondary guns. There will be four torpedo tubes. *Ueberall* considers that she marks a considerable advance upon her predecessors, but nevertheless is not sufficiently powerful.

THE TURBINE WARSHIP LUEBECK.—The *Luebeck* was the first German warship, excepting the torpedo-boat built at Schichau's Elbing yard, to be fitted with turbine machinery. She is a small third-class cruiser, of 3200 tons displacement, and has three sisters, the *Hamburg*, *Bremen*, and *Berlin*, all of which are propelled by two sets of ordinary reciprocating four-cylinder triple-expansion engines. The armament consists of ten 4-inch guns—two behind shields at the bow and stern, and three more on either broadside—ten 1.4-inch., and four machine guns. Two torpedo tubes for 18-inch torpedoes are carried, both of which are submerged. Her deck armor is 2 inches thick, with ¾-inch armor at the ends and 3¼-inch on the conning-tower. Her principal dimensions are: Length, 361 feet; beam, 40 feet; and draft, 17¼ feet; so that she is 33 feet longer than the preceding *Arcona* class, and carries a crew of 259 men. A longitudinal bulkhead divides the engine-room for the turbine machinery, and there are two smaller compartments for the auxiliary power. Each side of the ship has two shafts, driven by a high- and low-pressure turbine, all four of which can be reversed for astern steaming. Steam is generated by Schulz-Thornycroft boilers, and the indicated horsepower is 11,000. At this power the *Hamburg* made 23.3 knots, which the *Luebeck* is reported to have exceeded. If this is the case, the result tallies with competitive trials held between the *Topaze* and *Amethyst* in our own fleet, when the latter vessel reached 23.5 knots, or 1.2 knots faster than her sister. In both instances the turbine-engined vessel had a lower coal consumption than the reciprocating, which means an increased radius of action on the same supply of fuel. The *Dreadnought*, to be built at Portsmouth, is, it is said, to have turbines of 23,000 horsepower, and it is probable that in the new German battleships turbines will be fitted.—*Engineer.*

It is stated that the new German battleships of the *S* class of 16,000 tons odd will be 443 feet long, 78¼ feet broad, and 27 feet mean draft. The armament will be eight 11-inch 40-caliber guns, disposed as the big guns in the *King Edward*, and a dozen guns of 7.6-inch caliber in the main deck battery. The speed will be 19.5 knots.—*Engineer.*

The small cruiser *Ersatz-Alexandrine* was launched on September 23 from the Imperial Shipyard at Kiel. Her sister, *Ersatz-Meteor*, will be launched in November. These two ships complete the series (of eight small cruisers of 3250 tons and 23 knots speed) begun in 1902, and con-

sisting of the *Bremen, Hamburg, Berlin, Luebeck* (turbines), *Munchen, Leipsig, Ersatz-Meteor,* and *Ersatz-Alexandrine.* A new series will follow, of slightly larger ships, having half a knot greater speed and 500 miles greater steaming radius. This series already includes the cruisers *O, Ersatz-Wacht,* and *Ersatz-Blitz.*—*Le Yacht.*

DOCKYARD NOTES AND NEW SHIPS.—It is intended for the future that the Imperial Dockyards should be used more as repairing yards for the fleet than as building yards. The result is that the greater part of the ships to be laid down under the present year's programme will be built at private yards. Thus, the new battleship *Q* has just been laid down at the Krupp Germania Yard, Kiel; her sister-ship, *R,* will be built by the Schichau Yard, Danzig; and the new first-class armored cruiser *D* has been allotted to the firm of Blohm and Voss, at Hamburg.

During 1906 the number of battleships in the fleet will be brought up to 38, as fixed by the naval programme of 1900; but the construction of battleships will not then cease, as it will be necessary to lay down new ships to take the place of the *Sachsen* type, which were built in 1877-80, the German Admiralty having laid down the rule that battleships shall be considered obsolete after 25 years' service. The new first-class battleships *Preussen* and *Hessen,* of the 1902 programme, are ready; the new first-class armored cruiser *Roon,* begun the same year, is still under construction; the new first-class armored cruiser *York,* laid down in 1903, is ready for her trials; but with the battleships *Deutschland* and *Lothringen* not so much progress has been made. Of the ships begun in 1904, only the third-class cruiser *Leipsig* has been launched. The vessels still on the stocks are the four battleships *O, P, Q,* and *R,* building at the Vulcan Works, Stettin, the Imperial Dockyard, Wilhelmshaven, the Germania Yard, Kiel, and the Schichau Yard, Danzig, respectively, as already stated, the last two are in the very earliest stages of construction; the two first-class armored cruisers *C* and *D,* at Bremen and Hamburg respectively; the three third-class cruisers *O, Ersatz-Alexandrine,* and *Ersatz-Meteor;* one transport for submarine mines; one transport for ammunition; and one surveying-vessel. The third-class cruiser *O* is being built at the Imperial Dockyard, Danzig, as is also the *Ersatz-Alexandrine,* while the *Ersatz-Meteor* is being built at Kiel; it has not yet been made known where the two third-class cruisers of this year's programme, the *Ersatz-Wacht* and the *Ersatz-Blitz,* are to be built. *O* is to be somewhat larger than her sister, displacing 3400 tons, as against 3200 tons of the *Berlin* class.

The third-class cruiser *Ersatz-Alexandrine* was launched on the 23d September from the Imperial Dockyard at Danzig, and received the name of *Danzig.* Her dimensions are as follows: Length, 340 feet 6 inches; beam, 43 feet 4 inches; displacement, 3250 tons, on a draft of 16 feet 5 inches. There will be a 2-inch armored deck, and the conning-tower will also be protected by 3-inch armor. The armament will consist of ten 4.1-inch Q. F. guns, ten 1.45-inch Q. F. guns, with four machine guns, and two submerged torpedo-tubes forward for 18-inch torpedoes. The engines are to develop 10,000 I. H. P., giving a speed of 22 knots, while the coal capacity is 800 tons, giving a radius of action of 5000 miles at economical speed.

The naval authorities are considering the question of building two new entrances into the Kaiser Kilhelm Canal near Brünsbüttel and Holtenau. The canal locks now in use are 500 feet in length. It is known that the new battleships, in view of their increased displacement, will be appreciably longer than those now under construction, and as the canal locks cannot be made longer, it will thus become necessary to build two others at the entrance and exit of the Kaiser Wilhelm Canal, and each will have to be at least 667 feet long. At Brünsbüttel the Canal Board has been negotiating for the purchase of land required for a new lock. At Holte-

nau the Canal Board possesses a large tract of land lying to the southward of the mouth of the Canal, and the new lock will be built doubtless on the south side of the entrance.

The naval authorities are establishing another station for wireless telegraphy near Aarösund, on the Little Belt. Hitherto it has not been possible to communicate by wireless telegraphy between the stations on the mainland and any point northwards of Kiel as far as the Danish frontier. This extension is called for by the fact that, owing to the increase of the German navy, the waters lying between Kiel and the Little Belt will see much more of German warships in future. Germany will thus possess five stations for wireless telegraphy in the Baltic region; these stations are at Rixhöft, Arkona, Marienleuchte, Vülk, and Aarösund.—*United Service Institution.*

GREAT BRITAIN.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Dreadnought	18,000	Portsmouth	Building.
Lord Nelson	16,500	Jarrow (Palmer).	"
Agamemnon	16,500	Glasgow (Beardmore).	"
Africa	16,350	Chatham.	Launched May 20, 1905.
Britannia	16,350	Portsmouth.	" Dec. 10, 1904.
Hibernia	16,350	Devonport.	" June 17, 1905.
Armored Cruisers.			
Minotaur	14,600	Devonport.	Building.
Shannon	14,600	Chatham.	Launched May 20, 1905.
Defence	14,600	Pembroke.	Building.
Duke of Edinburgh	13,500	Pembroke.	Under trial.
Black Prince	13,500	Blackwall.	Launched Nov. 8, 1904.
Warrior	13,500	Pembroke.	" Nov. 25, 1905.
Cochrane	13,500	Glasgow.	" May 20, 1905.
Natal	13,500	Barrow.	" Sept. 30, 1905.
Achilles	13,500	Newcastle.	" June 17, 1905.
Devonshire	10,700	Chatham.	Under trial.
Roxburgh	10,700	Glasgow.	"
Scouts.			
Adventure	2,730	Elswick.	Under trial.
Pathfinder	2,610	Birkenhead.	" "
Attentive	2,750	Elswick.	Building.
Patrol	2,610	Birkenhead.	Launched Oct. 12, 1904.

THE EDUCATION OF NAVAL OFFICERS.—The following are extracts from the notes of the principal reforms undertaken by the Admiralty, 1903-05, issued with the Admiralty statement:

Midshipmen and Sub-Lieutenants.—After completing four years' shore-training in the Osborne and Dartmouth Colleges the cadets will join a sea-going cruiser for about seven months, where the training will be continued, and will have a more practical turn given to it. The final examination will take place before they leave the cruiser, and on this their seniority will depend. An award of time, according to the results of the examination, will be granted to the midshipmen as they now become, but this will not take effect until they are acting sub-lieutenants. After passing out from the cruiser the midshipmen of a term will be divided into batches of about 12 and each batch sent to a newly commissioned ship. All the midshipmen in one ship will thus be of the same seniority, and will be in the same stage of instruction in all subjects. An additional lieutenant will be appointed to each of these ships for charge of the midshipmen, but

there will be no naval instructor. It is confidently anticipated that these midshipmen on leaving the training cruisers will be fully as capable of taking the Part I Examination in Navigation and General Subjects as the present midshipmen are on completion of their sea service, and that it will only be necessary for them to keep up this knowledge whilst learning the practical subjects of their profession at sea. For this reason the abolition of the naval instructor has been decided upon. The additional lieutenant will be given the necessary courses of study to enable him to assist his midshipmen in keeping up the knowledge they have acquired, and will instruct them in seamanship, while the navigating, gunnery, and torpedo lieutenants will take charge of the instruction in their own branches. The engineer officer, besides giving practical instruction in engine-room and stokehold duties, will instruct in applied mechanics and their application to engineering. The midshipmen of each ship will be divided into sections for the purposes of instruction, one section working on deck with the commander, one working below with the engineer officer, another with the gunnery and torpedo lieutenants, etc., and the period of instruction in each branch will be continuous for two or more months. Examinations will be held annually, and will embrace papers on general mathematical subjects, in addition to the practical subjects of the instruction at sea. The period of instruction at sea will be three years, and at the end of this time midshipmen will be called upon to pass their examinations in seamanship and engineering before Boards of Officers. If successful, they will become acting sub-lieutenants, and seniority will be determined according to their success in passing from the cruiser as midshipmen. After passing for acting sub-lieutenant they will be discharged from their ships to return to England, and soon after arrival will undergo the examination in Part I of Navigation and General Subjects. This will be succeeded by short courses and examinations in pilotage, gunnery, and torpedo. At the termination of these courses they will be confirmed in their rank of sub-lieutenant, and those who have done sufficiently well will be selected for a further course of study in general subjects leading up to Part II of the examination. This course will be designed mainly as a preparatory training in science for those officers who will afterwards become specialists in gunnery, torpedo, engineering, or other subjects.

The Marine Officer.—In proposing that the officer for duty with the Royal Marines should be educated and trained as a naval officer, and that after undergoing a period of training in military duties he should be treated as a specialist officer, such as a gunnery or torpedo lieutenant, and be able to look forward to promotion to higher rank in the navy, the Admiralty are not making an entirely new departure. In the eighteenth century, when the Royal Marines were first constituted as a separate corps, naval officers held commissions as officers of Royal Marines, and some officers of great distinction, like Sir Cloudesley Shovell and Lord Howe, held the rank of major or colonel of Marines. These appointments were subsequently merely honorary, and carried with them good service pay, but as late as 1837 there were no officers of Royal Marines of higher rank than colonel commandant, the rank of colonel, major-general, and lieutenant-general being held by naval officers.

Apart from questions of rank the Royal Marines have been always intimately associated with the navy, and it is no disparagement to the marine officer to state that the efficiency and character of these military corps are largely due to their service under naval officers on board ship. In the last ten years some 8500 marines have been annually borne on the books of H. M. ships, and of this number one-third have been serving on ships without any marine officer on board. There is thus no reason to believe that the officering of the Royal Marines by naval officers will lead to less permanent control and discipline than has existed previously.

The naval officer who qualifies in military duties will be thoroughly competent to undertake the duties of the captain and major of Royal Marines

at the divisions as well as afloat, and as the Royal Marines as a body can never be available for brigading with the army (their services being required for the fleet), there can be no reason for maintaining a connection with the army which is one of name only.

It is not proposed in any way to alter the organization of the Royal Marines, or to change the uniform or titles of the rank and file to those of seamen, and the new class of officer will be introduced gradually so as not to affect in the slightest the prospects or position of the existing marine officers. Some slight alterations in matters of detail will be required to adapt the naval lieutenant to his position as captain of Royal Marines on shore, but no difficulty is anticipated. There will be no subalterns of marines in future, but only a few of them have ever been associated with the division, most being embarked, and it is considered that such duties as may be necessary can be carried out by warrant officers. In regard to this last point, it may be desirable to emphasize the fact that there is no regimental system in the marines, and as the marines will not have to fight on shore in the same way as the army, the subalterns cannot occupy the same responsible position.

Engineer Officers.—No fear need exist that the standard of engineering knowledge will be short of that which would have been attained under the previous tentative proposals, since the course and periods of active practical experience are precisely the same as those which were foreshadowed under the scheme as first propounded, optional reversion to executive duties during the period of commander's service being the sole alteration to the original proposals. Employment in any specialist work should not prevent an officer from gaining the executive knowledge and habit of command necessary for the position of captain of a ship. Experience has shown up to the present that the time spent by an executive or marine officer in the Naval Ordnance or Naval Intelligence Departments of the Admiralty has not unfitted him for his executive or marine duties, and that the time spent by an engineer officer in an Admiralty or dockyard appointment has not rendered him incapable of performing his duties as an engineer afloat. In the same way there is no reason why in future a short term of service at the marine headquarters, or at engineering work ashore or afloat, should incapacitate any officer, who is keen on rising in his profession, from the efficient performance of executive duties. But in order to obtain and maintain such complete interchangeability every facility for maintaining their executive efficiency will be given to specialist officers. Each specialist officer on board ship will be required occasionally to take duty on deck and in the engine-room whilst in the junior part of his service, and to perform the more responsible executive duties as his seniority increases. Every specialist lieutenant must pass the prescribed executive examination for the rank of commander, or else forfeit his claims to any higher executive positions. Further, no officer will be permitted to embark on a specialist course of instruction until he has passed all the examinations for the rank of lieutenant and has served continuously as sub-lieutenant or lieutenant for at least a complete year at sea; he must also have obtained the necessary certificates of competency in watch-keeping, etc., from his captain. It will probably be necessary to employ a proportion of specialist officers in their particular specialist work after they are promoted to the rank of commander, in order to obtain experienced officers for special positions. This employment will be regulated in the same way as the present appointments of commanders for navigating duties and of commanders filling special gunnery and torpedo appointments. It is further probable that more officers will desire to continue specialist duties than will be required to fill the appointments in the higher ranks. The Admiralty will thus obtain the power of selection for particular specialist posts in each grade, and at the same time any officer who desires to revert to ordinary executive duties will be able to do so, subject to the sanction of the Admiralty. A proportion of officers will, no doubt, for various reasons,

at some period relinquish hopes of filling the highest executive ranks and commands, and will prefer to continue in the specialist line for which their chief attainments may more particularly fit them.

Equal Opportunities for Promotion.—The following are the detailed arrangements for carrying out the new decision of the board that there is to be no permanent specialization of engineer and marine officers.

An officer entered under the new scheme who desires to specialize as a lieutenant for engineering, gunnery, marine duty, navigating, or torpedo, will be called upon to volunteer during the latter part of his service in the rank of sub-lieutenant at sea, and selections will be made annually from amongst those who are recommended. The officers who are selected for the various branches will then be withdrawn from sea service in time to begin the annual course of instruction, but no officer will begin a specialist course until he is promoted to lieutenant. The special course of instruction to qualify as engineer officer will include practical and observational work at a dockyard, and also theoretical work and laboratory practice in testing and experimenting. No manual work will be included in this course, as the officers will all have a sufficient knowledge of practical workmanship. On completion of the course and after qualification in the examinations, these officers will become lieutenants (E), and will receive extra pay as such in the same manner as other specialist officers, and will be qualified to perform the duties of a junior engineer officer afloat. In the largest ships only three engineer officers will be required in addition to the warrant officer watch-keepers, viz., a commander (E.) or senior lieutenant (E.) as chief engineer, a lieutenant (E.) as senior engineer, and a junior lieutenant (E.) as junior engineer.

The system of training officers for military duties (Lieut. M.) will be based on the probable nature of the work to be done by naval landing parties in war time or when undertaking isolated small expeditions. The course will include a study of the principles governing the attack by ships on coast defences, and on objectives on land or in harbor, and will also combine a sufficient knowledge of army organization to ensure efficient cooperation between the two services in the case of a joint expedition. Of the necessary training about half will be devoted to in-door study and half to practical out-door work. All duties in connection with musketry and battalion work, with field and machine guns, and also with physical training, will be delegated to the lieutenants (M.) instead of to the lieutenants (G.).

Higher Technical Appointments.—The filling of the higher technical appointments at the Admiralty and dockyards remains for consideration. It is probable that a fair proportion of those officers who go through the (E.) course will be officers who have special aptitude and inclination for engineering work, and who will devote their lives to that particular branch of the service, and that, consequently, many of them after passing the executive examination for commander, and so qualifying for the higher executive ranks, will forego the chance of executive commands afloat in favor of the important administrative positions in the Admiralty and at the dockyards which will be open to officers with high engineering qualifications. It is not possible at the present moment to lay down in detail what the course of instruction for these officers should be, since much depends on the results achieved during the period of qualification for lieutenant (E.), but it is considered that, after passing the examination for lieutenant (E.), a further course of about two years will be necessary to qualify officers for the higher engineering posts at the Admiralty and dockyards, subsequent periods of practical experience at sea being combined with service in the lower grades of these special appointments. At the end of the course for lieutenant (E.), a certain number of officers will be selected to proceed to the further course for lieutenant (E.†) and this course should follow immediately after the lieutenant (E.) course. In this way a practically continuous period of instruction will be secured.

On the completion of the higher (E.†) course these officers will be sent to sea-going ships for a period of at least one year, during which they will perform the duties of an engineer officer; they will then be available either to come on shore to a special appointment if their services are at once required, or to continue to perform the duties of an engineer officer at sea until they are needed to fill a special appointment. After a period of shore service these officers will again go to sea, in either an engineering or an executive capacity, as the service may require.

One of the three avenues through which the Royal corps of naval constructors is entered, viz., the Royal Naval Engineering College at Keyham, will shortly be closed. It is therefore necessary to widen the existing field of selection for members of this corps. This can best be done by including as candidates young men who have received a thorough grounding in mathematics, science, applied mechanics, etc., and the less advanced practical engineering work, but who may have had no opportunity of practical work at private shipbuilding yards. The restriction hitherto in force as to candidates having been through an apprenticeship in a shipbuilding yard will, therefore, be removed, and private students who enter at Greenwich for the course of training in naval architecture, preparatory to selection for admission as members of the Royal Corps of Naval Constructors, will in future be required to pass an entrance examination in mathematical and mechanical subjects, or to give evidence of equivalent qualifications, and to show a general acquaintance with practical engineering and mechanical subjects; the necessary shipbuilding and other practical work will be incorporated as a part of the Admiralty course of training.

The Training of Navigating Officers.—Until the institution of the Navigating School (H. M. S. *Mercury*), in midsummer, 1903, the training of navigating officers had been of the most desultory description. Navigating officers were selected from those who volunteered, and began either as sub-lieutenants or as lieutenants in small ships, with no further training than that which they had acquired at sea as midshipmen, and at the Naval College when passing for the rank of lieutenant. After three years' service as navigating officers of small ships, they were allowed to qualify for appointment as navigating officer of a first-class ship, and could present themselves for examination either with or without a short course of study at Greenwich. Under the recently abolished system the navigating officer, though in reality an executive officer, was always regarded more or less as a non-combatant, and he was seldom allowed to exercise any executive functions in a ship. This state of affairs was a survival of the traditions which had been handed down from the days of the old navigating line (which really was a non-combatant branch, and was abolished in 1883). In order to place the systematic training of navigating officers on a proper footing, it was decided to amend the conditions of entry into this branch of the service, and to establish a navigation school where thorough instruction would be given. Officers are now selected, as hitherto, from those who volunteer for navigating duties, preference being given to those who obtained first-class certificates in pilotage as sub-lieutenants, and selected candidates are sent to the Navigation School at Portsmouth. The course of instruction lasts ninety-days, and candidates after qualification are sent to sea to work as assistants under navigating officers of large ships. Before appointment to a ship as navigating officer they must obtain a certificate from the navigating officer under whom they have served as assistants as to their qualifications. Examination for first-class ship has been made compulsory, and must be undergone within a reasonable time after completing three years' service as lieutenant (N.). The compass course at Greenwich has been abolished, and one month's study in the Navigation School ship has been substituted. Lieutenants (N.) have also been placed on the same footing, as regards executive command and ship's duties generally, as gunnery and torpedo lieutenants, and are not exempt

from any ship's duties except those which directly interfere with the special work for which they are appointed.

The Navigation School is now being removed from H. M. S. *Mercury* to a shore headquarters at the Royal Naval College, Portsmouth, and two smaller gunboats, which are more convenient vessels for practical instruction, are being substituted for the *Mercury*. When this is done the instruction of acting sub-lieutenants in pilotage will be transferred from the College at Greenwich to the headquarters of the Navigation School.—*Army and Navy Gazette.*

LAUNCH OF THE NATAL.—The new first-class armored cruiser *Natal* was launched on the 30th of September, from the yard of Messrs. Vickers, Sons, & Maxim, at Barrow-on-Furness, the launching ceremony being performed by the Duchess of Devonshire. The dimensions of the *Natal*, which is a sister-ship of the *Achilles*, *Cochrane*, and *Warrior*, are as follows: Length, 480 feet; beam, 73 feet 6 inches; displacement, 13,550 tons, on a mean draft of 27 feet. Her armament will consist of six 9.2-inch and four 7.5-inch guns, the muzzle energies of which are 24,000 and 11,500 foot-tons respectively. Of the 9.2-inch guns, four are placed at the four corners of the citadel, while of the two others, one is mounted on the forecastle, and the other on the poop in gun-houses with 6-inch armored barbettes; the four 7.5-inch guns are mounted in casemates on the upper deck, also protected by 6-inch armor; she carries in addition, two 12-pounders, twenty-four 3-pounders, five Maxims, and two 18-inch submerged torpedo-tubes on the broadside and in the stern. Protection is afforded by an armor belt extending the whole length of the ship, and from 6 feet below the water-line to the top of the citadel, ranges in thickness from 6 inches—over two-thirds of the broadside—to 3 inches at the extremities. The machinery of the *Natal* is of the standard Admiralty pattern of four-cylinder triple-expansion type, all parts being interchangeable with corresponding parts of the machinery of sister-ships. The machinery is estimated to develop 23,500 I. H. P., at full power, making 135 revolutions per minute, and giving a speed of 22.5 knots. The value of the machinery is distinctly lessened by the fact that, although the late Boiler Committee's last report cancelled their previous advice that "one-fifth power of all ships should be generated in cylindrical boilers," this advice has been adhered to in these new cruisers because the specifications had been issued before the committee's final report was received. It seems a pity, therefore, that the Admiralty did not avail themselves of the opportunity to fit all these vessels with a complete installation of water-tube boilers. As it is, the *Natal* will have twenty Yarrow and six cylindrical boilers.—*United Service Institution.*

Two ocean-going destroyers of a new type, capable of running 35 knots, have been ordered to be built, one by J. S. White and Co., Cowes, the other at Thornycroft's new yard at Woolston. They are to be named the *Tartar* and *Cossack*.—*United Service Gazette.*

The cruiser *Warrior*, which will be launched at Pembroke Dock on November 25, will differ in armament from other vessels of the *Duke of Edinburgh* class by carrying, in addition to six 9.2-inch guns, six 7.3-inch guns. She is 480 feet long, and her displacement is 13,550 tons.—*United Service Gazette.*

Orders have been given by the Admiralty for the construction of the five ocean-going destroyers which were provided for in the navy estimates for the current year. They are to be named *Afridi*, *Cossack*, *Ghurka*, *Mohawk*, and *Tartar*, and will be built as follows: *Afridi*, by Messrs. Armstrong, Mitchell & Co., Newcastle; *Cossack*, by Cammell, Laird & Co., Birkenhead; *Ghurka*, by Hawthorn, Leslie & Co., Newcastle; *Mohawk*,

by Messrs. S. White & Co., Cowes; *Tartar*, by Messrs. Thornycroft & Co, Chiswick.—*United Service Gazette.*

The new battleship *Dreadnought*, in which so much interest is centered, was laid down at Portsmouth about October 4. She is to be ready for launching next February, and completed for sea within 16 months. In the first five weeks of her construction 2724 tons of material have been built into her, which is nearly seven times as much as was built into the *Royal Sovereign* and four times as much as was built into the *Majestic* in the same time.

Some comment and correspondence is being indulged in in some of our contemporaries as to how much mention may be made of the new battleship *Dreadnought*. Her name has to be mentioned with bated breath, and her armament—though privately known by everybody—must be mentioned only in the secrecy of the inner chamber. It is all somewhat farcical and also absurd, because the "secret" does not lie here but in some revolutionary constructional system of no interest to the general public, because they could not possibly understand it. The keeping secret of such details from foreigners is a very reasonable precaution—unless, as is possible, the experiment is a doubtful one. Then it were better to let some foreign navy get hold of it and carry out the necessary experiment.—*Engineer.*

A peculiarity of the *Black Prince* and *Duke of Edinburgh* class is that there are no bulwarks amidship between the central big guns, but flush open decks with railings. This is a considerable improvement, and it is to be a feature of all new British warships. The idea, which is borrowed from the French, will save many splinters in action.

Another point of interest is that the after fire-control station in these new cruisers is at the maintop, instead of low down on the mainmast, as in the *King Edwards* and *Devonshires*. All the guns, 9.2-inch and 6-inch, are of 50-caliber length. It is worthy of note that the *Duke of Edinburgh's* armor, owing to improvements, is equal to that of the *Majestic*, and her big guns have as good penetration as the *Majestic's* 12-inch, and, of course, fire more quickly. The sole features in which the *Majestic* is to the good are superior protection to vitals and big gun protection. By virtue of these the *Majestic* would probably come best out of a duel, but the fact remains that the armored cruiser of to-day is, taken as a whole, substantially of equal power with the "best possible" in the way of battleships ten years ago.—*Engineer.*

MOTOR-PROPELLED LAUNCHES FOR WARSHIPS.—It is proposed to supply the new British battleship *Dreadnought* with motor-propelled picket-boats in place of the usual steam pinnaces. Estimates have been obtained for two 50-feet motor-launches for the vessel, and it is believed that these will prove more economical than steam pinnaces. Meanwhile, the Admiralty is having a motor fitted into the hull of an old steam launch, and experiments will be made to ascertain the behavior of motor-launches in rough weather, and as to their suitability or otherwise for naval use. Should these trials have satisfactory results, it is understood that motor-launches will replace steam pinnaces throughout the British service.—*Nautical Gazette.*

Since 1893 there have been built for the British navy forty-six battleships, twenty-two armored cruisers, twenty first-class protected cruisers, and seventeen second-class protected cruisers, the total cost of construction being £81,154,268. Of this total of 105 vessels, forty-seven have been built in the Royal dockyards, twenty-eight battleships, five armored cruisers, and fourteen protected cruisers, the remaining eighteen battleships, seventeen armored cruisers and twenty-three protected cruisers having been

constructed by private firms. These figures and others, relative to the cost of each ship, are given in a Parliamentary return asked for by Mr. Kearley, which shows the number of ships of 5000 tons and upwards built for the Admiralty during the past twelve years in the dockyards and by contract, together with details as to the date of laying down, of launching, and of commissioning. There is also a column devoted to the excess or saving on the estimate for the cost of the ship, but no information on this point is given for any of the vessels. The total tonnage of the vessels under consideration is 1,191,865 tons, and the average cost per ton works out at a few shillings over £68.

Some very interesting comparisons in cost may be made by means of this return. For instance, the vessels of the *Empress of India* class cost on an average £949,636. Of these vesels three were built by the dockyards, four by contract. The average cost of the dockyard-built ships was £926,927, the four contract-built ships being much more expensive. In the same way with the *Duncan* class, the two dockyard-built ships averaged £1,063,242, while the four contract-built vessels cost about £1,096,203 each. With the *Formidable* class, all of which were built in the public establishments, we get the following results:—Devonport built three ships at an average cost of £1,092,004 each, Chatham built three ships at an average cost of £1,156,205, while Portsmouth built two ships at an average cost of £1,100,369 each. With the *King Edward VII* class, again, we get public and private yards in competition, with the result that, whereas the *New Zealand* and *King Edward VII*, the two dockyard-built ships, cost £1,481,203 on an average, the *Hindustan*, *Dominion*, and *Commonwealth* were built by private yards at an average cost of £1,458,364. The armored cruisers being mainly built by private contract, it may be interesting to compare the prices paid to each of them. The lowest average is that of the London and Glasgow Company, which built two of the *Monmouth* class for £731,883 each. Next come Armstrong, who built the *Lancaster* for £765,612, and then—a long jump—the Fairfield Company, which built two *Cressys*, a *Drake*, and two *Monmouths* for an average price of £820,485 each. Beardmore built a *Monmouth* and a *Devonshire* for about £831,585 each; Vickers' three ships, two *Cressys* and a *Drake*, cost on an average £877,530 each; the Clydebank Company, which built three similar vessels, charged £880,432 on an average for each one, and John Brown and Company built the *Antrim* for £899,050.—*Army and Navy Gazette.*

CHANNEL FLEET SPEED RECORD.—The speed record for Channel fleet battleships in the recent sea trials has been secured by the *Cornwallis*, of the *Duncan* class. Though nominally a knot slower, she succeeded in handsomely beating the *Swiftsures* and her sisters. On her eight hours' full power she attained 19.56 knots, with 18,500 indicated horsepower. At the three-fifths power run of sixteen hours, she made 16.3 knots with 11,000 indicated horsepower, and at the end of the run was 30 miles ahead of the next best ship. The speed of 19.56 is not the highest recorded for the class, because the *Duncan* once made 20.2, but the weather conditions were in the recent trial less fovorable, and so special credit has been gained. The various figures are:—

Designed horsepower.....	18,000 =	19 knots
Contractor's trial.....	18,238 =	18.98 knots (in bad weather)
Present service trial.....	18,500 =	19.56 knots

The coal consumption at full power worked out at about 15 tons an hour—a very good performance. The *Cornwallis* was built and engined by the Thames Ironworks Company, and fitted with Belleville boilers manufactured by the same firm.—*Engineer.*

SPECIAL BRITISH SHIPS FOR THE TRAINING OF ENGINE ROOM ASSISTANTS.—While the question of the engine-room staff on American warships is

being considered as a result of the late disastrous explosion on the gunboat *Bennington*, attention is called to a departure made by the British Admiralty recently, with reference to the training of men to fit them for service afloat. Heretofore engine-room artificers into the Royal navy have been recruited from private trades, the men being between 21 and 28 years of age. Able men, who have worked at the trade, and can show a certificate to that effect, either as fitters and turners, boiler-makers, engine-smiths or coppersmiths, are accepted if they can produce credentials of a satisfactory nature. A few pattern-makers and moulders are also taken on for work in the floating factories, but not for sea service. Of late years there has been considerable difficulty in getting recruits of a satisfactory nature; the different trade unions have not given encouragement to the men to join, and the change that has taken place in the custom of the trade has also led to a scarcity of suitable candidates. The engine-room artificers of the most numerous class must be both fitters and turners, and this also led to difficulty. In the Royal navy, naturally, demarcation of work—which has been so leading an article of belief ashore—is not recognized; so long as a man can carry out any operations, he is expected to do exactly as he is told. The increasing demand of the engine department for skilled men has led to engineer officers asking that such men may be properly trained in the service as boys. The late Engineer-Rear-Admiral G. H. Weeks, of the Fleet reserve and naval depot at Chatham, Eng., suggested that boys should be taken in and trained in the service, so as to fit them for the duties they would have to undertake afloat, with a special view to the work that they would be required to perform. This suggestion has lately been put in force, an extensive floating department having been instituted at Devonport.

The establishment is not under the immediate control of the navy professional officers, but under the commander-in-chief of the port; the work that is done is to a large extent supplied from the navy yard. The floating establishment is strictly under naval discipline; the lads who are being trained wearing a suitable uniform, and brought up in the traditions of the navy; at the same time they are thoroughly trained as workmen. There are schoolmasters attached for the necessary education of the lads; and, as will be seen in the description that follows, there are very complete arrangements for the workshop training and teaching generally, in order to turn out skilled workmen. The lads taken in are between the ages of 14 and 15½ years, and are the sons of workmen. They must serve for five years, and the last year is mostly employed on work for ships afloat. The *Bellerophon*, an obsolete armored cruiser, which was recently dropped from the British navy, has been rebuilt to conform to the work as an instructional factory and barracks combined, the lads living on board under sea discipline. On the upper deck a large number of new machine-tools have been installed, which have been purchased purposely for the work. They include lathes, planing machines, shaping machines, and, in fact, all the machine-tools of an engineer's workshop, and such as will be required to give the lads complete instruction in their various duties, as well as to carry out a certain amount of useful work, so far as can be arranged. The whole establishment is driven electrically.

Besides the *Bellerophon*, lying off the navy yard at Devonport, there are similar educational establishments at the Portsmouth and Chatham navy yards, where there are the *Asia* (a line-of-battleship) and the *Pembroke*, formerly the *Duncan* (also an old wooden battleship). These were formerly hulks for seamen, but they have now become available, as barracks have been built ashore. At Portsmouth also there is the *Assistance*, and the *Hecla* is at Chatham; these are repair-shops, and the boys work in them.—*Nautical Gazette.*

A War College for senior naval officers will come into existence at Portsmouth early next year. A scheme of reconstruction has been ap-

proved, which includes the erection of a lecture theatre in which war games may be played on a large scale. The present Naval College is being remodelled and will be turned into a school of Navigation and Pilotage. The classes in these subjects held at Greenwich will be transferred to Portsmouth on January 1, 1906. A sum of £11,000 is to be spent in adapting the Portsmouth Naval College buildings to their new uses.—*United Service Gazette.*

In the statement explanatory of the Navy Estimates issued last March, Lord Selborne stated that in the opinion of the board, a great development of the war course at Greenwich, inaugurated by the late Rear-Admiral H. J. May, would result, if it could be transferred to Portsmouth. There was at that time a lack of accommodation at the naval port, however, which prevented this being done, and the board proposed to build new quarters for the sub-lieutenants undergoing gunnery instruction and to appropriate the quarters in the naval college formerly occupied by them to the use of the officers undergoing the war course. The new buildings at Whale Island for the accommodation of the sub-lieutenants have now been completed, and the task of adapting the naval college to the requirements of its new occupants is being carried out. In addition to the officers undergoing the war course, there will be navigation and pilotage classes, under the command of Captain H. F. Oliver, and the officers taking those classes will enter the college at the beginning of next year. The house in the college, at present occupied by the captain of the *Excellent*, is to be given up in January next, a resident commander with quarters in the main part of the building is to be appointed, and the house will be converted into quarters for the senior officers undergoing the war course. Similar arrangements are expected to be made at all the ports, and the officers serving in ships in reserve will thus be able to attend the course without leaving their respective ports. The alterations at Portsmouth are all to be completed by Easter next.—*Army and Navy Gazette.*

The existing arrangements for providing naval officers with mess traps, cabin furniture, and lights have been undergoing revision, and a new system has been brought into working, as from April 1 last. By the new arrangements Government mess traps and replacements up to a fixed annual limit will be supplied free of any charge for percentage and depreciation to all flag officers and commanding officers, and to the ward-room, gun-room, and warrant officers' messes in sea-going ships. Moreover, the charges for cabin furniture in the case of all commissioned and warrant officers serving afloat have been abolished, and cabin furniture will in future be supplied free of payment. The lighting of cabins, messes, and officers' quarters will in future be undertaken by the Admiralty, including the requisite lamps, oil, and candles, and the allowance in lieu of lights has been withdrawn. It is the object of the Admiralty in introducing these changes to benefit the officers and others concerned, and in many ways the new system will undoubtedly be advantageous.—*Army and Navy Gazette.*

In a circular letter recently issued the Admiralty state that having had before them the question of facilitating the work of repairs to be carried out in ships of the fleet in commission at sea, and ensuring the vessels being completed within the period allowed for them to be in dockyard hands, certain alterations in procedure are to be included in the regulations. In preparing and forwarding lists of defects, which are to include only such work as is beyond the capabilities and resources of the ship's staff, these are to be sent to the dockyard to which each ship is assigned for the purposes of repair, so as to arrive there one month before the date fixed for the arrival of the ship. In the case of any fittings requiring special preparation all necesary details are to be sent with the defect list, together with accurate and fully-dimensioned sketches. Defects are to be grouped

in the following order: Hull, engines, boilers, auxiliary machinery, armament fittings, torpedo fittings, electric lighting, masts and yards, rigging, boats, and stores. Attention is directed also to the need for taking into account the age and fighting value of the ship when suggesting alterations and additions believed to be necessary for sea-going and fighting efficiency. Other circular letters recently issued deal with the issue of mess utensils for chief petty officers, and the special markings to be placed on packages containing explosives, including warheads, &c., for torpedoes, quick-firing ammunition boxes, and powder cases. The marking of the packages is to be done entirely at the depots, and Chinese red paint is to be used for the markings.—*Army and Navy Gazette.*

A return of the *personnel* of the navy in shore establishments and in ships in reserve has been issued in order to show the difference that the system of manning ships with nucleus crews has had. The total numbers borne in harbor ships, shore establishments, and ships in reserve at Portsmouth, Chatham-Sheerness, and Plymouth is 41,323, and this number includes 9806 men who form the nucleus crews of the ships in reserve. The total is taken on June 25 last, and the total at this time last year was 36,180. The number of men employed in ships in commission in reserve at Portsmouth is 3,540, at Chatham-Sheerness 3523, and at Plymouth 2743. The number of men at the gunnery schools is 6541, or 1120 less than on September 25 last year, while the number in the torpedo schools is 3063, as compared with 2674 last year. In the general depots there are 19,969 men, while twelve months ago there were 23,066, and at the signal schools there are 588 under training, practically 100 less than at the end of last September. The number of stokers under training in harbor has been reduced from 1504 to 642, and the number in depot ships for submarines has been increased by 120, the total being now 714.

Another interesting return shows the number of courts-martial held on seamen of the Royal navy, and the offences and the punishments awarded during the year 1904. From this report it seems evident that the discipline of the fleet is improving annually, though the number of offences tried by court-martial is still over 250. There were only twenty cases of desertion during the year, only sixteen cases of absence without leave, twelve of improperly leaving place of duty, and thirteen of drunkenness brought to trial by court-martial. There were 140 cases of striking or attempting to strike a superior officer, twenty-one of using threatening language to a superior officer, forty of wilful disobedience, and fifty-six of acts to the prejudice of good order and naval discipline. There were in all 270 persons brought before a court-martial, sixteen were acquitted, 138 received imprisonment with hard labor, eighty-eight imprisonment and dismissal with or without disgrace, four birching with imprisonment, two birching with or without dismissal, two were dismissed from the service, two disrated, and two severely reprimanded. The total of summary punishments inflicted on petty officers, seamen, and marines afloat during 1904 was 126,384, which is more than in any previous year since 1894; but the number of summary punishment inflicted on marines serving ashore is 1842, considerably less than the number for any previous year during the same period, and just over half the total inflicted in 1904.—*Army and Navy Gazette.*

Some interesting facts are brought to light in the returns of the number of courts-martial held and summary punishments inflicted on seamen of the Royal navy and Royal marines in 1904, which have just been issued. From these returns it appears that of those ashore 176 were tried during the year of whom 52 were charged with desertion, 42 with violence to superior officers and insubordination, 48 with making away with "necessaries," or portions of their kit, and 33 with absence without leave. None of the offences were sufficiently serious to merit a death sentence or penal servitude although 12 of the accused were sentenced to be discharged with

ignominy, and 146 to imprisonment with or without hard labor. Of the men afloat 443 were tried for various offences, eight answering charges of forgery, 55 of theft and embezzlement, and nine disgraceful conduct. All these were dealt with by the civil authority. Of the remainder, 140 cases were of striking or attempting to strike a superior officer, 21 of using threatening language, 40 of wilful disobedience, 53 with behaving with contempt to a superior officer, and 56 with the somewhat vague offence of "acts to the prejudice of good order and naval discipline." An abstract, showing the number of summary punishments awarded during the year, shows that there were 128,226 awards distributed among the 122,183 men borne on the books afloat and ashore.—*United Service Gazette.*

NAVAL EDUCATION.—A writer in *Blackwood* maintains that the system of training which produced Hawke, Anson, Rodney, St. Vincent, and Nelson, in the past, may be a safe guide for the future. That system was based on the idea that he who "goes down to the sea in ships" should become early accustomed to a sea life, and should possess a practical working knowledge of a ship and everything it contains. The irksome nature of a sea existence, to the majority of those who embark late on it, is a notorious and well-known fact. Not long since an international squadron was assembled in the same waters for several months. Foreign observers remarked of it that the great majority of the British naval officers appeared to be happy and in contented spirits, whereas the officers of the other navies were in quite the reverse mood, and openly expressed their longing to get home again. The remark was quite just. The reason for this difference in temperaments is believed to have been that the majority of the Britishers had become accustomed to a sea life at an early age.—*United Service Gazette.*

OIL STORAGE DEPOT.—In view of the success that has attended the experiments with oil fuel on board the battleships of the *King Edward VII* class as well as the smaller vessels which have been fitted for the consumption of this form of fuel, it is not surprising that the Admiralty have decided upon an extension of the facilities at the home ports for the storage of oil. The Turnchapel wharves at Plymouth, which have been used as a coaling depot for destroyers for some time past, are now to be taken in hand for conversion into an oil fuel storage depot. There will be a large number of reservoirs and tanks of sufficient capacity to meet all the requirements of the fleet in the immediate future, and a large number of jetties will be built for the use of tank vessels embarking oil fuel for transport to the fleet. As the requirements increase, so the system of storage depots will be extended to the other home ports, and there seems to be little doubt that oil fuel will play a large part in the propulsion of warships in the future. We have before now explained the advantages attendant upon the introduction of oil fuel, and though the disadvantages are still numerous, they are not insurmountable, and the general gain is on the other hand sufficient to justify extensive experiments with it.—*Army and Navy Gazette.*

NEW INDIAN TROOPSHIP.—Considerable interest attaches to the tenders which have just been received by the Indian Government for the construction of a new troopship, principally because of the penalties associated with the work. For a deficiency of 0.1 knot below the specified speed of 16 knots, the penalty is to be 175*l.*; for 0.2 knot, 400*l.*; 0.3 knot, 750*l.*; 0.4 knot, 1500*l.*; and half a knot, 2500*l.* In the event of the speed being less than 15½ knots, the vessel may be rejected. Under ordinary conditions builders might demur to the acceptance of such conditions, where there is very little latitude in the design of the ship for the prospective contractor, but with a naval architect of the experience and ability of Sir Edward Reed, K.C.B., who is the adviser for the Indian Government, no difficulty

is apprehended by the firms. Again, in respect of draft, it was found necessary to put forward heavy penalties, because this ship is intended to penetrate into many of the harbors of our Eastern dependency, where the depth of water is invariably limited. The draft is specified as 18 feet, and for an excess of 3 inches, the penalty is 3000*l.*; for more than 3 inches and not exceeding 6 inches, 7500*l.*; for more than 6 inches and not exceeding 9 inches, 14,000*l.*; and for more than 9 inches and not exceeding 12 inches, 25,000*l.* The vessel is to have a length of 360 feet, a breadth of 51 feet 9 inches, and a depth of 39 feet, and at the designed draft will displace 5820 tons. A speed of 16 knots is to be maintained on a six-hours' trial, and it is anticipated that with the two sets of three-crank triple-expansion engines the power required will be 7000 horsepower, obtainable with 116 revolutions. Two double-ended and two single-ended boilers are to be fitted, having Howden's system of forced draft, and working at 180 lb. pressure; while one small boiler, working at the same pressure, will run the auxiliary machinery. Generally, the ship, although smaller, will resemble in her fittings the troopship *Dufferin*, built some months ago by Messrs. Vickers, Sons & Maxim, and fully described in *Engineering*, great satisfaction having been experienced with the working of this vessel. A date has been specified for the delivery of the ship, and the penalty for late delivery will be 25*l.* per day.—*Engineering.*

ITALY.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Roma	12,625	Gov't Yard, Spezia.	Building.
Napoli	12,625	" " Naples.	Launched Sept. 10, 1905.
Vittorio Emanuele	12,625	" " Castellamare.	" October 1, 1905.
Regina Elena	12,625	" " Spezia.	" June 19, 1904.
Armored Cruiser.			
San Giorgio	10,000	Gov't Yard, Castellamare.	Building.
San Marco	10,000	" "	"
Pisa	10,000	.....	Projected.
Amalfi	10,000	.....	"

The new Italian battleship *Napoli* was launched on September 10, at Castellamare. The *Napoli* will form a division of four homogeneous ships with the *Vittorio Emanuele, Regina Elena,* and *Roma,* but this last will not be launched until this time next year. The *Napoli* was laid down on October 21, 1903. Her length over all is 474 feet; between perpendiculars, 435 feet; beam, 82 feet; draft 25.8 feet, displacement, 12,624 tons; number of engines, two; number of cylinders in each engine, four; number of boilers (Babcock & Wilcox), 22; engines, 15,200 horsepower under natural draft and 19,000 horsepower under forced draft; speed, probably 22.5 knots; ordinary load of coal, 1000 tons; special load, 2000 tons; radius of action at 12 knots with 2000 tons of coal, 10,000 miles; armament, two 12-inch, twelve 8-inch, sixteen 3-inch, two 2.95-inch, and ten 1.85-inch guns, two mitrailleuses, and four torpedo-tubes. Her armor belt will run her whole length and be 9.18 feet broad, with a maximum thickness of 9.84 inches. Protection for 12-inch and 8-inch guns, 7.87 inches; for small guns, 3.15 inches; for conning-tower, 9.84 inches. Her complement will be 36 officers and 679 men, or, when serving as flagship, 44 officers and 760 men.—*Nautical Gazette.*

MANEUVERS.—The Italian naval maneuvers have been in progress in the neighborhood of Maddalena, where the Red, or national squadron, had the duty of preparing for all the eventualities of a blockade, while the Blue, or hostile squadron, was the blockading force. The operations appear to

have been well conceived, and to have offered the opportunities of much practical work. The Red side is under command of Admiral Bettòlo, his squadron consisting of the *Dandolo, Ruggiero de Lauria, Francesco Morosini, Sicilia,* and *Sardegna,* with a certain number of smaller vessels, destroyers, and torpedo-boats. The Blue squadron, under command of Vice-Admiral Gualtero, consists of the *Regina Margherita, Benedetto Brin, Saint Bon, Emanuele, Filiberto, Varese, Garibaldi, Francesco Ferruccio, Vettor Pisani,* two smaller cruisers, several auxiliary vessels, five destroyers, and three squadrons of torpedo-boats at Civita Vecchia, one at Genoa, one at Messina, and some other vessels. We take these facts from the *Popolo Romano.—Army and Navy Gazette.*

JAPAN.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Kashima	16,500	Elswick.	Launched Mar. 22, 1905.
Katori	16,500	Vickers.	" July 4, 1905.
Satsuma	18,000	Yokosuka.	Building.
Aki	18,000	Kure.	Projected.
Armored Cruisers.			
Akoma	14,000	Kure.	Building.
Tsukuba	14,000	"	"
Ikubi	14,000	"	Projected.
Kurama	14,000	Yokosuka.	"

LOSS OF THE MIKASA.—Admiral Togo's flagship, the *Mikasa,* took fire at midnight on September 10, 1905, while lying at Sasebo, from an unknown cause. Before the fire could be controlled it reached the after magazine, which exploded, blowing a hole in the side of the ship and causing her to sink. There were a great number of men killed and injured. It is thought that the ship can be raised and repaired.

NEW CONSTRUCTIONS.—These will comprise, besides the *Kashima* and *Katori,* which are being built in England, the following ships: Two battleships, of which one is already begun at Yokosuka, of 19,250 tons, 18¼ knots speed, four 12-inch, twelve 10-inch and twelve 4.7-inch guns. Two armored cruisers, yet to be begun, of 14,600 tons and carrying four 12-inch, eight 8-inch, and fourteen 4.7-inch guns. Two armored cruisers, now building at Kure, of 13,750 tons, four 12-inch, twelve 6-inch and twelve 4.7-inch guns. Three protected cruisers, to be begun at once, of 4200 tons and 21 knots speed, probably with turbine machinery. Two scouts of 1380 tons and 23 knots, turbine machinery. Six torpedo boats.—*Le Moniteur de la Flotte.*

THE CAPTURED RUSSIAN SHIPS.—The four battleships, *Orel, Nicholas I, Admiral Apraksin,* and *Admiral Senjavin,* captured from the Russians at the battle of Tsushima, have been renamed the *Iwami, Iki, Okinoshima,* and *Minoshima* respectively. Considerable progress has been made in salving the Russian sunken warships. At Chemulpo, the first-class cruiser *Varyag* has at last been floated. At Port Arthur, the battleships *Poltava* and *Peresviet* have been refloated, and both ships have already arrived, the first-named at Maizuru and the latter at Sasebo, under their own steam. It seems quite certain now that the *Retvisan* and *Pobieda* will also be salved. The armored cruiser *Bayan* and protected cruiser *Pallada* have both been refloated; the machinery of the former has been damaged, but she has been safely towed to Maizuru. It has been ascertained that none of the Russian warships at Port Arthur were blown up

or sunk by gunfire. The Russians opened the Kingston valves, having previously greased or protected the machinery and vital parts of the vessels, and sank them to preserve them from the dangerous gunfire to which they became exposed after the capture of 203 Metre Hill, evidently hoping to recover them should the Baltic fleet succeed in winning back the command of the sea. The *Peresviet* has been renamed the *Sagomi;* the *Poltava,* the *Tongo;* the *Bayan,* the *Aso;* the *Pallada,* the *Tsugaru;* and the *Varyag,* the *Soya.—United Service Institution.*

According to the Japanese intelligence, instead of 150 wounded and thrown overboard, on the *Orel,* there were but 32 injured, of whom 16 were killed. The superstructures were destroyed, but the vital parts of the ship remained intact. One 12-inch and one 6-inch gun alone were put out of action. The *Orel,* now named *Iwami,* is now repaired and will soon be given a trial.—*The Yacht.*

Orders, it is reported, to the extent of £1,500,000, have been placed with Messrs. Krupp by the Japanese Admiralty, presumably for armor plates.—*Engineer.*

The *Nippon* gives a list of warships about to be laid down in Japanese yards: At Kure, battleship *Aki,* 18,000 tons; at Yokosuka, battleship *Satsuma,* 18,000 tons; at Kure, armored cruiser *Tsukuba,* 14,000 tons, to be completed in February, 1906; armored cruiser *Akoma,* 14,000 tons, to be launched in December; armored cruiser *Ikubi* 14,000 tons; at Yokosuka, armored cruiser *Kurama,* 14,000 tons.

The five submarines recently added, built in the United States in sections, gave such unqualified success that the squadron will be increased. The destroyer *Asakaze* was launched at Kobe on October 28, and four others are in course of construction, a second class cruiser and a despatch boat also being under construction at Sasebo. An immense gun factory with 20 large buildings, covering 83 acres, is being established on the Sumida river by the Japanese military authorities, where 4,000 men will be employed in making heavy ordnance.—*New York Sun.*

RUSSIA.

VESSELS BUILDING.

Name.	Displacement.	Where Building.	Remarks.
Battleships.			
Emperor Paul I.....	16,000	St. Petersburg (Baltic Yard).	Building.
Andrei Pervosvannui.....	16,000	St. Petersburg (Galerney Island).	Launched May, 1905.
Slava.....	13,516	St. Petersburg.	" Aug. 29, 1905.
Evstafi.....	12,500	Nicolaiev.	Building.
Ivan Zlatoust.....	12,500	Sevastopol.	"
Armored Cruisers.			
Admiral Makaroff.....	7,200	La Seyne.	Building.
Bayan	7,200	St. Petersburg	"
X	7,200	.....	"
X	7,200	.....	"
Protected Cruisers.			
Kagul	6,750	Nicolaiev.	Building.
Otchakof.....	6,750	Sevastopol.	Under trial.
Vitiaz	6,750	St. Petersburg.	Building.
Rurik	15,000	Vickers.	"

We learn from the *Moniteur de la Flotte* that the armored cruiser which is in hand at the Forges et Chantiers de la Mediterranée at La Seyne for

the Russian government has already made some considerable progress. She will be named the *Admiral Makaroff*, and will greatly resemble the *Bayan*, which was also constructed at La Seyne, but the new cruiser will be much more efficient than her predecessor. M. Lagane designed the original *Bayan*, and has made the plans for the *Admiral Makaroff*. The armament will include two guns of 8-inch caliber, eight 6-inch, twenty 3-inch, and eight 6-pdrs. There will be two submerged torpedo tubes. The *Moniteur* says that, in addition to the *Admiral Makaroff*, two other armored cruisers of the same type have been laid down in Russian yards, as well as a new *Bayan*, which has been begun at Galerney Island. There has been launched at Helsingfors a torpedo cruiser, which has received the name of *General Kondratenko*, in honor of the brave defender of Port Arthur. It is also stated that the work upon the battleships *Pavel I* and *Andrei Pervosvannui* has been suspended, for the singular reason that the engines are too big for the space allowed for them. A committee is investigating this question, and similar trouble is said to have arisen in the case of the battleships *Ivan Zlatoust* and *Evstafi*, which are both being constructed in the Black Sea. These difficulties are said to have arisen through an endeavor to introduce some improvements suggested by the battle of Tsushima, but we do not credit the story.

The same authority states that the 15,000 ton cruiser, of the *Terrible* and *Powerful* type, being built for Russia by Vickers, Sons & Maxim will be called *Rurik*. She is to be finished in a year and to have 24 knots speed.

Messrs. Vickers, Sons & Maxim are building a new Russian battleship not unlike the *Kashima* and *Katori*. This ship will, it is said, carry four 12-inch, four 10-inch, and fourteen 7.5-inch guns, most of which are in a main-deck battery. The armor is generally arranged as in the new Japanese battleships. The estimated speed is 18 knots, and steam is to be supplied by boilers of the Belleville type.—*Engineer.*

British advices are that the Vickers Maxim Shipbuilding Company has concluded negotiations for the sale of a new 20,000 ton battleship to the Russian government. The battleship was laid down by the builders in the hope that Russia or some other foreign power would buy it before completion. A second battleship is to be begun on the same lines.—*Iron Age.*

The large protected cruiser *Otchakof* is under trial in the Black Sea. It has taken three years to build her. She is a compromise between the *Olig* and the *Bogatyr;* has 23 knots speed and an armament of twelve 6-inch, twelve 3-inch, and six 45-mm. guns and two underwater torpedo tubes. Her sister ship the *Kagul* will not be ready for trial till 1907.—*Moniteur de la Flotte.*

UNITED STATES.

VESSELS BUILDING.

No.	Name.	Speed. Knots.	Where Building.	Per cent completed Sept. 1, 1905.	Per cent completed Dec. 1, 1905.
	Battleships.				
13	Virginia	19	Newport News.	92.9	97.
14	Nebraska	19	Moran Bros. Co.	79.6	83.
15	Georgia	19	Bath Iron Works.	86.4	90.3
16	New Jersey	19	Fore River Shipbl'g Co.	89.3	93.7
17	Rhode Island	19	Fore River Shipbl'g Co.	93.0	98.
18	Connecticut	18	Navy Yard, New York.	86.2	92.7
19	Louisiana	18	Newport News.	86.4	92.6
20	Vermont	18	Fore River Shipbl'g Co.	61.4	68.7
21	Kansas	18	New York S. B. Co.	60.1	67.7
22	Minnesota	18	Newport News.	71.2	77.1
23	Mississippi	17	Wm. Cramp & Sons.	38.7	45.7
24	Idaho	17	Wm. Cramp & Sons.	38.7	42.6
25	New Hampshire	18	New York Shipbl'g Co.	18.2	29.2

UNITED STATES.—Continued.

VESSELS BUILDING.

No.	Name.	Speed Knots.	Where Building.	Per cent completed Sept. 1, 1905.	Per cent completed Dec. 1, 1906.
	Armored Cruisers.				
6	California	22	Union Iron Works.	81.8	86.2
9	South Dakota	22	Union Iron Works.	80.6	84.9
10	Tennessee	22	Wm. Cramp & Sons.	84.3	90.
11	Washington	22	New York Shipbl'g Co.	83.9	89.4
12	North Carolina	22	Newport News.	15.0	28.8
13	Montana	22	Newport News.	13.0	22.3
	Protected Cruisers.				
20	St. Louis	22	Neafie & Levy Co.	75.7	83.6
21	Milwaukee	22	Union Iron Works.	80.6	86.
22	Charleston	22	Newport News.	99.7	99.9
	Scout Cruisers.				
	Chester		Bath Iron Works	0	13.3
	Birmingham		Fore River Shipbl'g Co.	4.7	18.4
	Salem		Fore River Shipbl'g Co.	4.3	14.3

THE MISSISSIPPI.—The *Mississippi*, which was launched on September 30, is one of two sister ships, the other being the *Idaho*, authorized by act of Congress approved March 3, 1903, and is the result of a compromise; one party in Congress was in favor of building 16,000-ton ships, while another party favored smaller ships, of a displacement not to exceed 12,000 tons. The compromise was effected by the authorization of three ships of 16,000 tons, now known as the *Minnesota, Vermont*, and *Kansas*, all three of which have been launched, and two of 13,000-tons, of which the present is one. The contract for the construction of the *Mississippi* was signed January 25, 1904, the price for hull and machinery being $2,999,500, and the contract date of completion March 25, 1907, this being thirty-eight months from date of contract. The keel was laid May 12, 1904, so that a period of sixteen months and eighteen days has elapsed between laying the keel and putting the ship into the water. According to the monthly report from the Bureau of Construction and Repair, the *Mississippi* has now reached a stage of completion represented by about 43 per cent.

The ship has a water-line length of 375 feet, a beam of 77 feet, and a normal draft of 24 feet 8 inches, the length over all being 382 feet. The displacement on trial, with a load including 600 tons of coal, is to be 13,000 tons, at which the engines, designed to develop 10,000 horsepower, are expected to give a speed of 17 knots. With the full bunker capacity of 1750 tons of coal and full stores and ammunition on board, the displacement becomes 14,465 tons. The machinery consists of twin-screw, triple-expansion engines, with cylinders measuring respectively 25½, 42, and 69 inches in diameter and a common stroke of 48 inches. These engines are operated by steam furnished by eight Babcock and Wilcox boilers, with a total grate surface of 768 square feet and heating surface of 32,640 square feet, this giving a ratio of 42.5 to 1. The estimated steaming radius at ten knots is 5750 nautical miles.

The *Mississippi* is one of the most powerfully armed battleships afloat, and is without exception the most powerful of her size. The main battery consists in four 12-inch and eight 8-inch breech-loading rifles, mounted in pairs in six turrets; the 12-inch guns being on the center line forward and aft, and the 8-inch guns at the four corners of the citadel on the main deck. In addition to these, there are eight 7-inch rapid-fire guns mounted behind 7-inch armor on the broadside, and a secondary battery consisting of twelve 3-inch, six 3-pounders, four 1-pounder rapid-fire guns,

two 3-inch field guns, and eight automatic machine guns, together with two 18-inch torpedo tubes of the submerged type.

The protection includes a complete water-line belt, having a thickness amidships of 9 inches and tapering to 4 inches at the ends. The turrets for the 12-inch guns have a thickness on the exposed side of 12 inches and on the rear of 8 inches, while the corresponding thicknesses of the 8-inch turrets are 6½ and 6 inches. The barbettes for the heavy guns are 10 inches in the exposed side and 7½ in the rear, with corresponding figures for the 8-inch guns of 6 and 4 inches. A complete protective deck is fitted, measuring 1½ inches on the flat and 3 inches on the slopes. The crew will consist of 34 officers and 691 men.—*Marine Engineering.*

ADMIRAL EVANS ADVOCATES 18,000-TON BATTLESHIPS FOR OUR NAVY.—Rear Admiral Robley D. Evans, commander-in-chief of the North Atlantic fleet, is a strong advocate of the construction of battleships of at least eighteen thousand tons displacement, and as much heavier than that as is necessary to accommodate the necessary batteries, armor, machinery, and equipment.

The largest American battleships yet authorized are the sixteen thousand ton Connecticut class. Rear-Admiral Evans' views on this subject, as well as all others connected with the service, command attention. For several years he has favored both greater displacements and more guns of larger caliber.

"I favor the construction of 18,000-ton battleships," Rear-Admiral Evans remarked, "provided they are large enough. Moreover, 18,000 tons should be the minimum. The displacement is to be determined by the batteries she is to carry and the handiness of the ship. The naval constructor should be told what batteries the ship is to carry and its general dimensions with reference to handiness. He must then give the necessary displacement for the accommodation of that battery, with the necessary handiness, speed and coal endurance.

"In every case there should be at least a division of four battleships of the same speed, dimensions, battery and tactical qualities.

"So far as the speed is concerned, I do not want more than eighteen knots, and when I say this I mean eighteen knots an hour maintained sea speed.

"Many officers are advocating a speed of twenty-two knots an hour for battleships, but I look with a great apprehension upon the merging of a battleship into a cruiser. In such a case you lose the good qualities of both types. In the one case you lose the fighting qualities of a battleship and fail to get the speed of the cruiser, and in the other case you sacrifice the speed of the cruiser and fail to get the endurance of the battleship.

"Without discussing the claim of tactical advantages for the faster squadron made by the advocates of great speed, it seems clear to me that the sacrifice necessary in guns and armor to produce the faster ship is so great that she must inevitably be whipped by the slower ship, which can and will have better protection and carry heavier guns. Under such conditions tactical advantages disappear, for whatever position the faster fleet may take tactically speaking the vessels will be subjected to a fire of guns heavier than their own and they will necessarily carry the lighter armor.

"I would increase the displacement of the sixteen thousand ton battleships *Michigan* and *South Carolina*, authorized by the last Congress but not yet designed, to the point of displacement which would enable them to carry a main battery of 12-inch guns alone.

"My experience at sea leads me to believe a fleet of 20,000-ton ships can be maneuvered as well as a fleet of 15,000-ton ships. A few years ago the idea of our handling a 15,000-ton ship was considered impossible, but experience has shown that they can be maneuvered as well as

5000-ton cruisers. The personnel of the ship responds readily to the increase in size. Above 20,000 tons I am not so certain as to this."—*Nautical Gazette.*

ORDNANCE AND GUNNERY, TORPEDOES.

New regulations for the award of prize money for shooting in the navy have been framed. They apply to warships of all classes, and their object is to encourage good shooting. The prize money is divided under three heads, namely for good shooting with heavy guns and with light quick-firing guns in the larger ships and for good shooting with quick-firing guns in torpedo-boat destroyers. In the first case the annual capitation grant on the authorized complement is 1s. 3d, 6d. per man being allowed for prizes at the annual tests of gunlayers, and the other 9d. going for accurate work at other competitions, and for proficiency in loading and aiming teaching appliances. For skill with the light quick-firing guns the sum of 6s. a gun is to be awarded at the annual gunlayers' test. The annual capitation allowance in connection with the quick-firing guns in torpedo-boat destroyers is the same as with the big guns in other vessels, and is divided up in much the same way. The prize-money dealt with in these regulations is to be considered as quite separate from and additional to any medal bonus that may be awarded under the Admiralty circular letter of October 9, 1903.—*United Service Gazette.*

Rear-Admiral Percy Scott, who has gone to Gibraltar to attend the battle practice of the Atlantic fleet, is credited also with an intention to inquire into the results of some recent prize-firing, certain of the vessels not having made such good scores as might reasonably have been expected. It will be remembered that the results of the prize-firing for this year will not, in the ordinary course of events, be made known until some time next spring, but among the other reforms which it is expected will follow upon the establishment of the department over which Rear-Admiral Scott presides, is the earlier publication of these figures. One good result that would follow from this would be that any ship low down in the list one year would be made aware of her shortcomings before the subsequent competition was entered upon, and an additional incentive would be given to her officers and men to achieve better results. It has been stated that the gunsights of three of the newest vessels of the Atlantic fleet have been found very defective, and this is another matter to which Rear-Admiral Scott is assumed to be devoting attention.—*Army and Navy Gazette.*

The *King Edward VII* flagship of the Atlantic fleet, which has just completed her battle practice under the new conditions, showed a great improvement upon her previous record. With the vessel steaming at fifteen knots the following was the results of the practice at 6000 yards: 12-inch guns, 11 rounds, 10 hits; 9.2-inch guns, 31 rounds, 15 hits; 6-inch guns, 71 rounds, 26 hits; total, 51 hits out of 113 rounds. Rear-Admiral Percy Scott, director of target practice, was present during the firing.—*United Service Gazette.*

During its stay at Quiberon the French squadron had target practice for determining the order of merit of its ships. The firing was against three targets, the ships steaming past them at 6000 meters distance, battleships at 12 knots' speed and cruisers at 16 knots. The *Gloire* particularly distinguished herself by demolishing all three targets.—*Le Yacht.*

The light armament of battleships is the subject of an article in the *Moniteur de la Flotte.* It is now recognized that the medium armament

will be suppressed for the excellent reason that the battles of the future are likely to be fought at longer range than it is possible to attain with such guns. Hence the lighter armament will have for its purpose to deal only with the attack of torpedo craft. The character of the light gun becomes, therefore, a matter of great importance, and the *Moniteur* discusses the right caliber and the grouping of these guns in sections in various parts of the ship. What is necessary is a gun discharging a projectile of caliber and velocity sufficient to perforate, at distances of from 1500 to 2500 meters, the plating of smaller warships and the thin armoring which is being given to the new destroyers. Nevertheless, the caliber must be limited in order that the large number of these small guns may be installed with an adequate supply of ammunition. The guns ought to be very easily handled and of very rapid fire, with proper sighting adapted to the special work. Moreover, they ought to be grouped in sections in such a way as to deal with an attack directed from ahead or on either beam or from astern. There should be at least four groups, and the guns should be so mounted that the chief of the section could exercise proper control and direction. Each section would have its own ammunition hoist. At least four guns would be mounted to constitute a section, and they would fire volleys to enable the effect of their range and fire to be appreciated. The right caliber for the guns is thought to be the 75-mm. (2.9-inch pr.), which the French have adopted.—*Army and Navy Gazette.*

The gunlayers' competition in the Mediterranean this year is reported to have given extremely good results, but full reports are wanting. It is noteworthy, however, that the flagship has again made remarkably good practice, and that from the 12-inch guns in the after turret nine hits were made from ten rounds. This is on a par with the performances of the *Terrible* with her 6-inch pieces, and of the *Scylla* with the 4.7-inch, and though the new regulations as to the expenditure of ammunition and the conditions governing firing practice, have doubtless contributed to this happy result, it must also be in some measure due to the personal influence of the officers. With the record of the *Majestic* and the *Cæsar* behind him, it is only reasonable to suppose that the admiral should be anxious to bring the *Bulwark* to the fore, and set an example to the other vessels of his fleet. The competition in the ships of the China division of the Eastern fleet is also reported to have been satisfactory, the *Hogue* and the *Astræa* having both made good scores. The *Andromeda* also, at a range of 7000 yards, secured a large percentage of hits, but the actual figures will not be obtainable until the official report is published.—*Army and Navy Gazette.*

In the gunlayers' competition at Malta the *Bulwark*, the flagship of Admiral Lord Charles Beresford, has made a record for the 12-inch guns, the after turret obtaining ten rounds and nine hits, the fore turret thirteen rounds and eight hits. The total by the 12-inch guns of the *Bulwark* is twenty-three rounds and seventeen hits, which is believed to be a world's record. In the 6-inch gunlayers' competition 103 rounds yielded seventy-three hits, or 6.083 hits per gun per minute. This is the best result obtained in the Mediterranean fleet.—*United Service Gazette.*

On September 1 a further series of experiments in night firing with live shell were carried out by the guns' crews in the Spithead forts. A target representing a torpedo-boat was towed at fifteen knots, and at an unknown range, past the forts, and was subjected to a heavy bombardment. The men seemed to find the range very accurately, and the number of hits registered was very considerable, the target being practically blown to pieces. The practice began at eight o'clock, and there were a large number of people watching the proceedings from Southsea beach. This week also tests of the defences at Devonport have been carried out, a network of wire

entanglements being suspended between the two old screw sloops *Mariner* and *Reindeer*, moored at either side of the narrow entrance to the harbor to prevent the ingress of torpedo craft. The defence is not really of the boom type, the only booms employed being those used for the protection of the *Mariner* and *Reindeer*. Special arrangements were made with regard to the stoppage of traffic while the tests were proceeding, and a number of attacks on the defence were delivered by destroyers and torpedo-boats of the Devonport reserve division.—*Army and Navy Gazette.*

It may be interesting to give here the scores of the ships of the Mediterranean fleet as far as they are known at present. The *Leviathan* made 59 hits, four from her 9.2-inch and 55 from her 6-inch guns; the *Queen* made 51 hits; the *Prince of Wales* 28, four from the 12-inch and 24 from the 6-inch guns; the *Bulwark* and *Formidable* tied with 25 hits each, the *Bulwark's* score being all made with the 6-inch guns, while the *Formidable* had two 12-inch gun hits and 23 6-inch; the *Implacable* had 15 hits to her credit, the *Lancaster* 11, and the *Irresistible* 10, but this last-named vessel includes in her score three 12-inch gun hits, and has, therefore, a better record in actual fighting value than the *Lancaster*, which only scored with the 6-inch guns. The *Leviathan*, of course, is the flagship of the third cruiser squadron, and Rear-Admiral the Hon. Hedworth Lambton must be congratulated on having beaten the record achieved by Vice-Admiral Sir William May's flagship, the *King Edward VII*, only a week or two back. The publication of the official battle practice and gunlayers' test returns will enable us to judge more carefully of the results of this year's competitions, but there can be no doubt that the spirit of emulation is growing up among the gunners of the fleet, and it is that spirit which we must do all in our power to stimulate.—*Army and Navy Gazette.*

A new 11-inch gun is being adopted for the *S* class of German battleship, and, unlike previous German service pieces, it will be of fifty calibers in length. The muzzle velocity is reported to be 3000 foot-seconds, but this, perhaps, is an optimistic view, as German service velocities are usually well under the highest possible, and there is much conservatism in this matter. In any case, however, it will be a very powerful piece.—*Engineer.*

HIGH VELOCITIES AND GUN EROSION.—The biggest problem, in the development of war material at the present time, is to overcome the terrific erosion which burns out the inner tube of our modern high-velocity guns. The success of Admiral Togo in defeating the enemy by long-range rifle fire has directed attention more than ever before to the advantage of high velocity and big guns. There are two ways in which the punishing range of the gun can be extended; one is by increasing the velocity of the projectile, and the other is by increasing its weight. The disadvantages of increasing the weight are that less ammunition can be carried per gun, and that the loading of the gun is somewhat slower and its rapidity of fire is reduced. On the other hand, if the muzzle velocity be increased, the same striking energy can be developed at the same range without any increase in the weight of the projectile, and if a powder containing a high percentage of nitroglycerine be employed, there need be no serious increase in the weight of the charge. The United States government prefers to use a powder with less nitroglycerine than is present in the English cordite; but although it has succeeded in obtaining as high, and a little higher velocities at the proving grounds, this result is gained at the cost of using a powder charge that is over twice as heavy, the cordite charge for a 12-inch gun weighing 141 pounds, and our nitrocellulose charge weighting for the same gun, 350 pounds.

Nature, however, demands a heavy toll from those artillerists who seek to secure greater range by higher velocity; for in order to secure high

velocity, the powder pressures within the gun must be raised to such a degree that the corresponding temperature plays the Old Harry with the inner tube, the white-hot gases melting it away, just as a block of ice is melted by a stream of boiling water. Up to a certain limit, pressures and temperatures may be raised and velocities increased without serious injury to the lining of the gun; but above that point the inner tube begins to deteriorate, the rifling is burnt out, the projectile fails to rotate on its axis, and begins to tumble end over end in its flight.

We do not hesitate to say that to-day the greatest problem in the development of artillery is the prevention of gun erosion.

There are no great mechanical difficulties to be encountered in getting high velocities. There are to-day at Sandy Hook under test by the Board of Ordnance of the army, two 6-inch wire-wound guns, each of which has shown muzzle velocities far in excess of anything that is used either ashore or afloat to-day. One of these is a design by General Crozier, the present head of the Bureau of Ordnance, and the other is the well-known Brown wire-wound gun, the distinguishing feature of which is its inner core of laminated steel plates. We have before us some of the results that have been obtained during the tests of the latter gun at Sandy Hook. These include sixty-five rounds fired with powder charges of from 32 to 72 pounds, with corresponding muzzle velocities of from 1913 feet per second to 3380 feet per second, and with powder pressures ranging from 12,274 pounds per square inch to 43,370 pounds to the square inch. The high velocity of 3123 feet per second was reached in the fourth round, and in the rounds from that up to the sixty-fifth round the velocities have ranged from 3200 feet per second up to 3380 feet per second, and most of them have been over 3300 feet per second. We understand that structurally the gun has shown no signs of weakness whatever, and the indications are that, were it not for the erosion troubles, the velocities could be carried up to 3500 feet per second, and the gun would prove to be perfectly well able to carry these velocities in service. Unfortunately, in both this gun and the Crozier gun, which has been tested simultaneously with it, that universal enemy of the artillerist, erosion, is getting in its destructive work. Thus we are once more reminded that the question of the ultimate practicable velocities of our guns is a question for the chemist, the metallurgist, and the powder expert to determine. We are squarely up against the fact that our steel makers cannot provide an inner tube that will endure the terrific heat engendered by modern smokeless powders. Furthermore, our artillerists admit that they do not know what is the exact explanation of erosion, whether the action is mechanical or chemical, or both. This is a field that will well repay investigation. The remedy may be found in the projectile, or in the tube or liner, or in the powder; but probably a careful study of the question of proper obturation will give the quickest solution of the difficulty.—*Scientific American.*

NIGHT-FIRING EXECUTED BEFORE THE GERMAN EMPEROR AT SASSWITZ.—In the battle of Tsushima, during the nights of May 27 and 28, the Japanese torpedo-boats, as is known, inflicted serious damage upon the Russian ships of the line. It is doubtless on account of this experience that the German Emperor, during his recent stay at Sasswitz, ordered trials made with a view to the practical determination of the chances of hitting torpedo-boats in rapid motion, at night, with the small caliber projectiles of a battleship. The armored cruiser *Prince Adalbert,* serving as a gunnery ship, was designated to execute the fire against the torpedo-boats, which, to the number of six, of the oldest types, were filled with cork to keep them afloat, and towed to Sasswitz by tugs. During the night, the *Prince Adalbert,* having the Emperor on board, put to sea. The cruisers *Undine* and *Nymphe* followed with the six old torpedo-boats. The formation taken during the night was as follows: In the middle, *Prince Adalbert;* parallel to that ship, to left and to right, *Nymphe* and

Undine, each towing, by means of a cable 1000 meters long and buoyed with cork, three torpedo-boats. The two towing cruisers steamed at the full speed of 21 knots, towards Sweden, while the *Prince Adalbert* steamed at 19 knots' speed towards Swinemunde, thus giving a relative speed of 40 knots. The captain of the armored cruiser knew only that the torpedo-boats followed 1000 meters behind the *Nymphe* and *Undine*. But he and the ordnance officer had exactly calculated this small difference of time; the firing began not a second too soon, the second shot already hit, and the shots followed each other with terrific rapidity, but in the twinkling of an eye the torpedo-boats had disappeared.

Throughout the whole navy the great success of the *Prince Adalbert* in this exercise against torpedo-boats is eagerly discussed. The Emperor, during the whole firing, was in the fighting top and closely observed the fall of the projectiles. He did not conceal his satisfaction and himself congratulated the gun-captains; five of the best were given medals. Truly remarkable was the success of one gun-captain who made 27 hits out of 35 shots. And the other gun-captains were all excellent; they made 39 per cent of hits; out of 15 shots from 6 to 8 hits. This night-action shows that with good gunners a ship of the line has little to fear from torpedo-boats. The night attack of the Japanese torpedo-boats against the Russian armored ships had so much success on account of so many faults on the Russian side; for example, the excessive use of searchlights by the Russians notably aided the commanders of the Japanese torpedo-boats in directing their boats against their enemies.—*Revue International.*

The old gunboat *Rattlesnake* was submerged on Friday last in Portsmouth harbor, and then blown up with 300 pounds of guncotton. The object of the authorities was to discover the effects of submarine explosions, and the time needed to remove a wreck of that type from a channel. —*United Service Gazette.*

TORPEDOES AND ARMOR PLATES.—The French navy has carried out at Gavres, near Lorient, an interesting series of submarine experiments, suggested by the naval combats of the Russo-Japanese War. The object was to test on a large scale the effects of the various makes of torpedoes under practical fighting conditions, and especially in their action upon armor plates in a state of immersion. For this purpose armor plates to represent the hull of a ship were placed in position at low water, together with torpedoes, and when the tide was at its height the torpedoes were exploded, sending up columns of water fifty yards into the air. At the same time there was tested an ingenious appliance for launching torpedoes, invented by Captain Baudret-Lacantiniere, and the primary experiments having proved promising, the appliance is to be fitted up on one or two torpedo-boats for further tests. As to the results of the torpedo experiments, the most profound silence is observed.—*United Service Gazette.*

A DISCREDITED THEORY.—After reading the description of the ridiculously small results recently achieved at Sandy Hook in the test of a torpedo shell against a target representing the side of a battleship, our readers will surely agree with us that Congress should make no further appropriations for experiments with projectiles of this kind. The only effect produced on the trial plate, as the result of bursting 183 pounds of high explosive against it, was a slight indentation, which was due, almost entirely, to the striking energy of the shell itself. While we can well understand that the enormous energy of gases of explosion of guncotton or nitroglycerine should have caused the idea of exploding a heavy charge against the outside of a battleship to appeal very strongly to the lay mind, we cannot understand why Congress should have authorized this latest trial of the theory, when that theory had been so completely discredited in the tests of the Gathmann torpedo shell some four or five years ago.

Let it now be set down once and forever that not 200 pounds, nor twice 200 pounds, of high explosive is sufficient to "blow the modern battleship out of existence." If the events of the naval conflict in the Far East have taught us anything at all, they have surely taught us this: That unless the charge should be so fortunate as to explode in or at the neighborhood of the magazine, a single torpedo or a single mine will not send a battleship to the bottom, or wreck it beyond the possibility of repair. If anyone doubt this, let him look at the Port Arthur fleet, the ships of which, after receiving some of them not one, but several blows, full and square from the mine and the torpedo, were so far repaired under emergency conditions, as to be able to go forth and fight that seven-hour engagement with the Japanese fleet on August 10.

Modern ship steel is so tough; the modern system of cellular and compartmental construction is so elaborate; the modern battleship is so big; and its inertia so great, that the detonation of even 400 pounds of high explosive against the side of the ship, as in the case of the *Sevastopol*, causes damage which, though extensive, is strictly local, and does not impair the structural integrity of the ship as a whole. The high-explosive armor-piercing shell, which can carry its bursting charge intact through the armor and liberate its energy within the vitals of the ship itself, is the supreme engine of destruction in modern naval warfare; and the thin-walled torpedo shell must be relegated to that museum of discredited inventions, of which the Sandy Hook proving ground contains so many costly exhibits.—*Scientific American.*

On September 8, the French squadron practiced with torpedoes off the bay of Fret. The targets were towed by three torpedo destroyers. The ships fired by divisions, the divisions following one another at 2000 meters distance.—*The Yacht.*

BRITISH SUBMARINE DEFENCES.—The decision to eliminate submarine mines from our (the British) system of coast defence, has given rise to a great deal of comment in service circles. A huge additional expenditure is involved, yet the result will be to destroy the security which has been created by years of study and by the best engineering and scientific skill. The Committee of National Defence has decided that the defence of British ports by submarine mines shall be abolished on the ground that the system is antiquated, and that the mines are more dangerous to defenders than to assailants.

The defence of ports and harbors by means of submarine mines is a highly technical business, concerning which the layman cannot dogmatize. So long as the professional experts are in the main agreed among themselves upon such a subject, the layman may well be content to perform his part, which is to provide the requisite money. But so soon as the professional experts begin to differ one from another, the old difficulty arises. Which party is right?

The naval critics say that "it has been a standing joke in naval circles for many years past, that the only ships ever likely to be operated upon by these submarine defenders are our own," and assert that the system belongs to the dark ages of coast defence, and that its survival, long after the decay of the sort of reasoning to which it owes its birth, has been a matter of surprise for some time past. "All sound strategists are agreed," they say, "that no serious attack need be apprehended on our naval arsenals and home ports, so long as our fleet is maintained at a proper standard of strength. And, moreover, if our fleets are unable to keep the enemy's warships at a respectful distance, no mine-fields will be of any avail to save our ports from destruction; no hostile visitor need run the risk of being blown up while, by lying five miles off a town, it can bombard the inhabitants into a reasonable frame of mind."

To this, the military advocates of submarine defences make reply that there are many harbors within easy raiding distance of our coasts, whence flotillas of torpedo-boats, steaming, say, thirty knots, and numbering in all, say, twenty-five, fifty, one hundred units, could simultaneously, or in rapid succession, raid a selected harbor and get home again, doubtless after heavy loss, but having done an infinitely greater amount of damage. It is safer to take a long sight than a short one. To ascertain how many hours such a raid would require it is only necessary to consult a map. They would not be many, while it is possible that it might take place simultaneously with or before the declaration of hostilities. Such things have happened before, and may happen again. Submarine craft and torpedo-destroyers alone could not resist such an attack. Submarine mine-fields, themselves under the protection of quick-firing guns, capable of sinking torpedo-boats, close the entrances of harbors, and their chief object is to render such damage impossible, and to give the navy an added chance; there is no stupid rivalry on the part of the submarine miners, but loyal co-operation.

Such, in brief, are the contentions of the two schools of thought—"blue-water" and military. How are we to solve the question as to which is right? Until quite recently the port and harbor defences, by means of submarine mines, were in the hands of the army. Then came the announcement that they were to be transferred to the navy, followed by Mr. Balfour's pronouncement that "the submarine mine is—at all events as far as this country is concerned—a very inexpedient method of attempting to secure the safety of these ports. . . . . Further, it has been decided that the system of submarine (observation) mines shall be abolished, torpedo vessels and submarines being employed instead."

The public cannot follow these technical matters very closely, and the magnitude of the change involved has not therefore been yet grasped by the country. But stripped of all *technique*, the position to-day is that the navy alone must defend our harbors and ports and keep off the invader. At present these harbors and ports are cheaply and efficiently guarded against surprise attack by submerged mines, but in future they will have no protection whatever, except such as may be given by submarine boats and torpedo craft, and that, even if the great additional cost be accepted without demur, is a poor substitute for the existing system, the merits of which have never previously been seriously questioned. There are two classes of ports in the Empire—the commercial ports and the naval ports. The former are of supreme importance for our actual material wants, the latter are vital to our navy, which must protect commerce in time of war. In the past the commercial ports have been protected by a few guns, and in many cases by the provision of floating or submerged mines, while the naval ports have been heavily protected by guns and mines.

Except by those who are opposed to submarine defences, there are very few persons who have made a study of this matter who will dispute the statement that when mines of the British service pattern are laid down in any harbor or estuary, they absolutely close it to an invader and yet leave it perfectly safe for the ingress or egress of friendly vessels. No human power except that of the man who depresses the electric key at a distant point on shore, can effect their discharge. It is quite certain that these mines have hitherto exercised a deterrent effect on a fleet, and materially increased the strength of the land fortresses. Now that the mines are to be no longer utilized, the only alternative offered us for the defence are guns and Brennan torpedoes. Needless to say that the opinion is rapidly gaining ground amongst service experts, that this decision of the National Defence Committee is one of the most dangerous that has ever been arrived at, and unless we are very careful, a terrible price will one day be paid for this extraordinary change of defensive policy.

One special point claims particular consideration. We have at the present moment two thousand regulars, two thousand militia, and two

thousand volunteer submarine miners who form the most perfect organization of its kind in the world. They provide an absolute guarantee against effective surprise attacks on British harbors. All this preparation will be thrown away to make room for a system, the success of which is very problematical. If it be true that the proposal is approved by the naval experts, surely it would be an ample concession to them to apply the change only to the naval bases on which they depend. The great commercial ports ought not to be deprived of their protection before shipowners, chambers of commerce, and others who are deeply interested have an opportunity of expressing their views, after hearing the opinions of eminent engineers and mining experts. As things appear at present, we seem to be passing from safety and efficiency to danger and inefficiency, and we are doing this at a cost which may be twenty times as great as the present system of harbor defence. Moreover, the changes involved dispense with the services of eleven companies of royal engineers, besides the militia and volunteer submarine miners. What is more natural than that the eleven companies will eventually be wiped out altogether? The temptation to lessen the strength of the army and to effect a grand economy will prove too much for any War Secretary—although he might well pause to consider, before scattering such a body of men, how he would ever gather their like together again.

The submarine mining defences are still intact, the personnel is yet maintained and is practically inexpensive, being mainly composed of militia and volunteers. May we hope that even at the last moment the order for their extinction may be abrogated?—*United Service Gazette.*

MISCELLANEOUS.

STEAM TURBINES AS APPLIED TO OCEAN LINERS.[1]

BY PROFESSOR J. HARVARD BILES.

When the writer agreed to give a paper on this subject it was hoped that detailed results of the running of the only two complete turbine ocean liners would have been available. The owners and builders of these steamers readily promised such information, but the preliminary difficulties inherent in such a radical departure have taken more time to overcome than some expected, and the results obtained have not been as good as they will be, and are, therefore, not worth publishing. It may, however, be stated that the results completely justify the adoption of the turbine in ocean liners, and that your ex-president, Mr. Parsons' annexation of the whole field of high-speed marine propulsion, from the small type of torpedo-boat to the Atlantic greyhound, is now complete. This year the British Admiralty have ordered a set of turbines for a battleship, the latest and largest type, and it is quite possible that we have seen the last of the reciprocating engines for the main propulsion of warships. Such a revolution in the type of machinery has never before been seen; such a great change has certainly never taken place in so short a time. The first turbine steamer that was built for practical purposes was named the *King Edward.* She was begun since our King ascended the throne, early in 1901. Since then a sister vessel, the *Queen Alexandra,* has been built for the same service as the *King Edward.* Cross-channel steamers *Queen, Onward, Invicta,* for the Calais route; the *Brighton* and *Dieppe* for the Newhaven route; the *Princess Maud* for the Stranraer route; the *Londonderry* and *Manxman* for the Heysham-Belfast route; and several others have been built and running successfully all within about four years of the date of the first trip of the *King Edward.* British torpedo-boat destroyers *Viper, Cobra,* and *Eden,* and a third-class cruiser, the *Amethyst,* have been built

[1] Read before the British Association, 1905.

and successfully tried. The United States navy have recently ordered some fast scouts, which are to be fitted with turbines. The French have built a destroyer, the Germans are building at least one warship for turbines, so that the application to all types of high-speed vessels has now reached a practical stage, which will give engineers an opportunity of the complete study of the question of the relative efficiency of the new and the old methods of utilization of steam and propulsion of ships.

Before saying anything about ocean liners, it may be well to shortly state the position of the efficiency of the turbine as far as it has been determined to-day. Mr. James Denny, one of the builders of the *King Edward*, gave the result of her working as compared with the paddle steamer which she succeeded. She showed a gain of 20 per cent. Of this 5 per cent was due to the reduced weight, and 15 per cent to its increased efficiency. Captain Williamson, one of the owners of the *King Edward*, gave the relative coal consumption of this vessel as compared with a paddle steamer of the same speed on service as in the ratio of 1 to 1.32. The paddle engine is not the most efficient propelling agent, and the results are more than usually favorable to the turbine.

The destroyers *Cobra* and *Viper* obtained 36 knots speed against a maximum of 31 knots in the other destroyers of the same dimensions having reciprocating engines. This represents a gain of not less than 25 per cent in production of power. The cross-channel steamer class has given an excellent opportunity for developing the new system of propulsion, because the work is thoroughly practical while the vessels are constantly at work, under observation of the managing staff. They can be readily laid off for the examination and adjustment, which are so much more necessary in the developing stage than at a later one. Two sets of results are available for this class. First, those of the *Queen*, the first cross-channel steamer fitted with turbines. Secondly, those for the *Londonderry* and *Manxman*, designed by the writer and his partner, Mr. William Gray.

The results are given in the following tables:

Comparison of Results of Turbine Steamer Queen and three other Steamers on same Route having Reciprocating Engines.

All results are comparative. None are absolute.

	Dimensions.	Per passenger certified to be carried. Coal per H. P.	Coal Burnt.	No of E. R. staff.	Oil used.	Cost of coal E. R. staff.	Speed.
Queen	323×43	1.00	1.00	1.00	1.00	1.00	21.0
B	324×35	1.43	1.74	2.03	2.97	1.8	18.0
C	280×35	1.25	1.25	1.47	2.47	1.34	18.9
D	313×36	1.9	2.07	1.73	2.69	2.06	17.9

The first column gives the engineering efficiency, from which it will be seen that the gain over the best of the old type is in ratio of 5 to 4. The commercial and enginering efficiency combined are given in the other columns, and the results are very striking. All the gain may not be due to the turbines, as some may be due to the increased efficiency in passenger carrying in the *Queen*, but this cannot be very great. It seems as if comparatively the net gain in commercial efficiency is higher than that in engineering efficiency alone. These figures have been supplied by Captain Dixon, the marine superintendent of the S. E. and L. C. D. Railways.

The results of the running of the turbine steamers *Londonderry* and *Manxman* are, from an engineering point of view, equally interesting. These two vessels are of exactly the same form as the vessels *Antrim* and *Donegal*, designed at the same time by the writer for the same service, and having reciprocating engines. The latter vessels are identical, and it is thought that they are highly-efficient representatives of their class.

The two former differ only in the matter of turbines. The *Londonderry* has turbine power sufficient to obtain the same as the vessels with reciprocating engines. The weight of machinery is less, and the saving in the weight reduces the displacement and the resistance of the vessel, so that the power for the desired speed is less. This advantage to the turbine shows in its first cost, as well as in the cost of running, and it leaves the comparison with the reciprocating engine as one which includes in favor of the turbine the incidental advantages due to its light weight. One of the savings in weight in the *Londonderry* was in the boilers, which, though of the same size and number as the other vessels, had a reduced pressure of 150 lbs. instead of 200 lbs. In the case of the other turbine vessel, the *Manxman*, the same saving in weight was not made, but a more powerful turbine was put in, and the boiler pressure was not reduced as in the *Londonderry*. By this arrangement the greatest power which the boilers could give was obtained, regardless of the weight of the turbine, instead of, as in the other case, the smallest weight for a given power. The net result was a maximum gain in speed of three quarters of a knot, which, if the efficiency in the other two ships were the same, is the equivalent of a gain of 14 per cent of power when the extra resistance due to the extra weight is allowed for. It is difficult to determine how much of this gain is due to the turbines, as the propellers were different in the three ships, and probably had different efficiencies. But from the result of steam-consumption observations, it appears that, at about the maximum speed of 22 knots of the *Londonderry*, the slower vessel, the extra power required was more, while the resistance was less, the net difference in efficiency of turbine and propeller being at least 12 per cent in favor of the *Manxman*, the faster vessel. If this gain in efficiency were maintained throughout to the full development of *Manxman's* power, there would only be a net increase of power developed in the turbine of less than 2 per cent. It is difficult to say whether the efficiency would or would not be maintained, and so one is left in doubt as to the relative efficiency of the larger turbines with the higher pressure, though it seems probable that it is represented by a small percentage, about 2 per cent.

As to the comparison between the turbines and the reciprocating engines and propellers combined, their comparative efficiencies are at 20 knots' speed, in the following ratios: *Antrim* .97, *Londonderry* 1.0, and *Manxman* 1.11.

Let us turn, however, from the water consumption and speeds on trial to the results on service, which are more interesting commercially than those given above.

It is difficult to eliminate effects of weather, tide, loading of vessels, and the other matters which affect results on service, but a fair average can be obtained if sufficient observations are taken. The method of comparison adopted is to find from the logs all the voyages in which two chosen ships were running on the same night in opposite directions. Omitting from these all cases in which full speed was not maintained in the open sea, for all the runs the following results were obtained:

R—Reciprocating. T—Turbine.	Antrim R.	Lon. T.	Lon. T.	Don. R.	Don. R.	Man. T.	Man. T.	Antrim R.
Number of trips	48	48	42	42	39	39	29	29
Average coal per trip	35.6	35.3	36.9	36.0	38.7	40.2	38.6	38.6
Average speed in knots	19.7	19.5	19.8	19.2	19.3	20.3	20.3	19.5
Speed								
Coal consumed	10.9	10.76	10.62	10.24	9.59	10.25	10.67	9.85
Coal consumed per cent in favor of	1.30	—	3.6	—	—	6.6	8.2	—
			Londonderry.			*Manxman.*		
Mean per cent in favor of turbines			2.4			7.7		

This method of measuring efficiency by the ratio of the square of the speed to the coal consumed assumes that resistance varies as the square of the speed. If the actual water consumption curves be used, the results at the same speed give an average advantage of the *Manxman* over the two reciprocating engine vessels of 8.9 per cent.

It will be seen that the advantages of the *Londonderry* over the *Antrim* on trial was 3 per cent, but that it changed to a disadvantage of 1.3 per cent on service, making the *Antrim* 4.3 per cent better on service, relatively to the *Londonderry*, than she was on trial. The similar figures, *Antrim* and *Manxman*, show the latter 24 per cent better on trial, but 8.2 per cent on service, a gain for the *Antrim* of 5.8 per cent as between trial and service conditions.

It is seen that the efficiency on service seems to be less marked in the turbine than it is on trial. It may be that with the increase of resistance due to the sea wind and foul bottom the turbine propellers are less efficient relatively as they are so small, but it is reported that in bad weather there is less racing in the turbines. Until we have careful water-consumption tests systematically carried out this point will remain doubtful.

It seems certain, however, that 8 or 9 per cent of gain may be relied upon if the turbines are as efficient as those of the *Manxman*.

The weight of the *Manxman's* machinery, and the part of the hull lightened, turned out to be 115 tons less than the *Antrim*, a saving of 15 per cent in the total weight of engines and boilers, etc.

It may be remarked that the reciprocating machinery referred to is the very best of its kind, and is of the highest attainable efficiency for this class of machinery.

With reference to the warship machinery, the Admiralty built four vessels of the same form and dimensions. Into one they put turbines and in the three others reciprocating engines. The vessels' dimensions are 360 feet by 40 feet by 14 feet 6 inches draft; displacement, 3000 tons. The reciprocating engines developed 10,000 indicated horsepower, and the vessels attained a speed of 22.1 knots. The turbine vessels attained a speed of 23.6 knots. Water consumption trials gave at 22.1 knots 215,000 lbs. per hour in the reciprocating engines against 190,000 lbs. at 23.6 knots in the turbine. The difference in speed of 1½ knots at the same efficiency of propellers represents about 20 per cent difference of power, and one would expect to find the same difference in water consumption. This would increase the 190,000 lbs. to about 230,000 lbs., as against the 215,000 lbs. actually used in turbine. This shows a gain in favor of turbine of 7 per cent. Here again we have only the combined relative efficiency of turbine and propeller, but if the small propeller is inefficient, it is a necessity of the turbine, and if it is more efficient than the large propeller, it may be taken as an incidental advantage of the turbine. The former is probably the truth.

Four 2170-ton turbine vessels, of dimensions 275 feet by 44 feet by 16.6 feet have been built, and are running for the British India Company from the Persian Gulf to India, having speeds of 18 knots, which involve about 6000 horsepower. A vessel of 2448 tons, of dimensions 300 feet by 43 feet by 25 feet, named the *Loongana*, for the Union Company, of New Zealand, having a speed of 20 knots, and about 6000 horsepower, on trial, has steamed from Scotland to New Zealand, and is there successfully running. These two cases are between cross channel steamers and the large ocean liners.

Coming to the question of ocean liners, there two ships, the *Virginia* and the *Victorian*, of the Allan Line, fitted with turbines. The particulars of the first of these vessels are as follows:

Particulars of Turbine Steamer Virginian.

Name	Virginian.
Owners	The Allan Line Steamship Company, Ltd.
Builders	Alex. Stephens & Sons, Ltd.
Date	1905
Length	520 ft.
Breadth	60 ft.
Depth	41 ft. 2 in.
Maximum load draft	29 ft. 6 in.
Displacement on trial, about	13,000 tons
Speed on trial	19½ knots
Revolutions of propeller, each	285
Engines, three steam turbines	High pressure in center Low pressure and reversing at sides
Boilers—Number	6
Diameter	17 ft.
Length	12 ft.
Pressure	180 lbs.
Heating surface	30,800 sq. ft.
Grate surface	726 sq. ft.
Tonnage, net	6,844
Tonnage, gross	10,755
Number of first-class passengers	470
Number of second-class passengers	200
Number of third-class passengers	650
Number of passengers gained by fitting turbines	60
Weight of machinery saved	400 tons

The mean speed across the Atlantic is 17 knots, and the coal consumption is practically the same as for triple-expansion engines of the most modern type. There is no doubt that when a proper adjustment of form, area, and pitch of propeller to the boiler power and the form of the ship has been reached in these ships, the turbine system will prove an advance upon, and, indeed, supersede, the reciprocating engine for vessels of this class. The best results obtained have not yet been so good as the steamers are capable of, and, therefore, there is no possibility of saying anything more definite as to the efficiency of turbines in ocean lines at present than that they have justified their adoption in such vessels.

The Cunard Company are carrying out an interesting experiment, as, like the Midland Railway Company, they have reciprocating engines and turbines in two exactly similar vessels, the *Caronia* and *Carmania* respectively. The former has attained 19½ knots on trial, and 18 knots at sea. They are vessels 678 feet long over all, 72 feet beam, and 52 feet depth. Their draft will be at least 32 feet, and at that draft will displace 30,000 tons. They will carry 300 first, 350 second, 1000 third-class passengers, and 1000 steerage. The engines of the *Caronia* developed 22,000 indicated horsepower on trial at 19½ knots.

The *Carmania* has three turbines, one high and two low. Her turbines have been made by her builders at Clydebank, and are the largest yet constructed for marine or any other purposes.

MARINE APPLICATIONS OF THE CURTIS STEAM TURBINE.[1]

BY CHAS. G. CURTIS.

The first vessel to be propelled by steam turbines of this type, and the first vessel of any kind to be fitted with twin shafts and screws and twin

[1] Paper read before the Society of Naval Architects and Marine Engineers.

turbines independently controllable and reversible, was the yacht *Revolution*, built in 1902. This yacht had a length of 140 feet on the water-line, beam of about 17 feet, a draft of 7 feet, and a displacement of about 200 tons, and was provided with two independent turbines of about 1200 H. P. each, turning outward and designed to run between 650 and 750 revolutions under full speed conditions. The turbine casing, including the reversing mechanism, was only 5 feet 10 inches in diameter and about 4 feet long. The turbines were not designed to show any remarkable economy, but were expected to consume about the same amount of steam as an ordinary triple-expansion engine under the usual conditions of service. This yacht was put into commission in the spring of 1901 and was kept in commission and used for exhibition purposes continually, with the exception of two months during one winter, for a period of a year and a half.

The practical operation of the turbines was in every respect most satisfactory and convincing, neither one ever having required any repairs of any kind, and the steam consumption was shown by torsion shaft test to be substantially equivalent to that of ordinary triple-expansion engine under average working conditions. The boat, however, failed to develop the speed anticipated, and it was a long time before we could find out why this was so. The impression seems to have got abroad among marine engineers that the failure of this boat to show a speed consistent with the high power provided was in the main due to a failure of the turbines to develop the necessary H. P. Such was not the fact. One of the turbines when driving the screw in the ordinary way, was subjected to a very careful torsion shaft test by Prof. James E. Denton, who, with Prof. Webb, devised and worked out an ingenious and accurate method of measuring the angle of twist of a specially calibrated length of torsion shaft introduced into the line shaft for this purpose. The tests showed that the turbines developed the full power expected, and that the steam consumption was about 17½ lbs. per I. H. P. The results are given in the following table:

Power and Economy of One Turbine.

Number of steam passages in use.	Revolutions per minute.	Brake H. P., or H. P. delivered to propeller.	Indicated H. P. of equivalent piston engine.	Dry steam per hour indicated H. P. of equivalent piston engine.
1	2	3	4	5
4	748.0	1096.0	1267.0	17.46
3	672.8	761.6	898.7	18.14
2	596.6	467.1	572.0	19.12
1	452.5	192.3	269.5	21.34
1 throttled	265.3	95.7	146.2	24.67

The failure to get the expected speed, viz.: 21 to 21½ knots under conditions where the boat actually showed only about 18 knots, furnishes another illustration of how easy it is to "fall down" in an engineering matter of this kind, even when the best knowledge and talent are availed of. In order to insure success we not only had the vessel designed by a well known firm of yacht designers and builders who had previously built a yacht which was and still is the fastest yacht in this country, but we had the yacht's model tested in the government testing tank in Washington, and the screws were designed by a very distinguished authority in this country. Several sets of screws were built for the boat, the last set having a diameter of 4 feet, and a pitch of 4 feet, and having thin blades of well known form. From what is now known of the action of propellers of this character and from the fact that the turbines did develop the power expected, we have been led to conclude that the trouble with the *Revolution* was in her model, which, in the afterbody is very bad, her floor not being drawn out aft far enough. This view is confirmed

by the best marine architects whom we have consulted about the matter and who have observed the wave action of the boat, which is very excessive, even at a speed of only 18 knots.

The reversing and maneuvering capacity of the *Revolution* was even better than anticipated, and was very satisfactory. In a maneuvering test made by a board of the Navy Department it was found that when going ahead at full speed (about 18 knots) the boat was brought to a standstill in the water in 32 seconds after the engine-room telegraphs were thrown over. The boat was used extensively about New York harbor for a year and a half, and her reversing power was called into play to the utmost very frequently, but it never failed to respond with the necessary power, and during the whole period of her use as a "demonstration" no trouble of any kind whatever was had with either of the two turbines.

Some time ago the Fore River Shipbuilding Co., of Quincy, Mass., at the instance of its very able and progressive president, Admiral Bowles, and after an investigation into the comparative merits of the two types of steam turbines available for the purpose, entered into contracts for the construction of two large vessels to be equipped with twin independent Curtis turbines, which vessels, together with the turbines, the Fore River Co. is now building. One of these is the U. S. scout cruiser *Salem* and the other is the Southern Pacific steamer *Creole*, particulars of which are as follows:

	Salem.	*Creole.*
L. W. L.	420 ft. 0 in.	415 ft. 8 in.
Breadth	46 ft. 8 in.	53 ft. 0 in.
Draft	16 ft. 9½ in.	25 ft. 0 in.
Displacement	3,750	10,160 tons
Horsepower	16,000	8,000
Speed	24 knots	16 knots

In both vessels there are two shafts and two screws with complete independent turbines on each shaft. In the case of the *Salem* the proposed revolution of the screw at 24 knots is 350; in the case of the *Creole* somewhere between 225 and 275. The space occupied by the turbines for and aft (including the reversing mechanism) is only about half that occupied by the equivalent triple or quadruple-expansion four-cylinder engine and the weight is considerably less. In the case of the *Creole* the weight of the two turbines is, roughly speaking, about half of that of the equivalent quadruple expansion engine. The total saving in weight of the engines, shafting, propellers, etc., is very considerable. Each turbine is in the form of a drum-shaped shell, built up in sections, having an outside diameter of about 11 feet and an overall length of about 14 feet. Each turbine comprises 7 stages for going ahead and two stages for reversing. There is no end thrust due to the pressure of the steam in the turbine itself and the propeller thrust is taken up by the ordinary thrust block external to the turbine.

During the past summer the Vulcan Shipbuilding Co. of Germany completed a turbine vessel called the *Kaiser*, which is fittted with two shafts and two independent turbines of this type. The turbines were built for the Vulcan Works by the Allgemeine Elektricitats Gesellschaft of Berlin, who are licensees under the Curtis Turbine Patents, and were designed by and built under the very able direction of Mr. O. Lasche, the technical director of the turbine works of the Allgemeine Company. The performance of these turbines and of the vessel on her trial trip was admirable, and reflects great credit upon Mr. Lasche and his associates, and also the designing engineers of the Vulcan Works, who assumed the responsibility of getting efficient screw action under the unusual conditions. The guarantees were intended to represent the performance of a first class 4-cylinder triple-expansion engine and the ordinary slow turning screws which necessarily have a somewhat higher efficiency than the comparatively

high revolution screws requisite for turbine propulsion. The actual figures guaranteed were a speed of 19½ knots, and a consumption during a 6-hour run of not over 4700 kgs. of coal per hour, including all auxiliaries. Progressive speed trials were had up to 20.46 knots, the propellers turning at 655 revolutions per minute During a 6-hour run 20 knots was averaged on 4060 kgs. of coal per hour. We have not yet ascertained positively what the H. P. developed was, but we understand that the shaft H. P. was measured by the use of a torsion, and we understand on good authority that the indicated H. P. of the engines for the ship at 20 knots is estimated at 5700. Whether this is derived from the shaft H. P. measurement or confirmed by the shaft H. P. measurement we do not as yet know. But if this figure—5700 I. H. P.—sent to us is correct, the coal works out at 1.56 pounds per I. H. P., including all auxiliaries. The coal result is, if anything, better than these figures show, for during two hours the safety valves were blowing and the steam by-passing to the condensers. On a basis of the cube of the speeds the H. P. at 20 knots would be 8 per cent greater than that at 19½ knots, and as the coal consumed at 20 knots was only .864 per cent of that guaranteed for 19 knots, it would appear that at a speed of 19 knots the coal consumption would be just 80 per cent of the amount guaranteed.

The dimensions of the vessel are as follows:

Water-line length, 310 feet.
Beam, 38.2 feet.
Draft on trial trip, 9.74 feet.
Displacement, 1890 tons of 2240 pounds.

In order to test the maneuvering and backing qualities of the turbines, which were entirely independent, another engine-driven vessel belonging to the same line (the Hamburg Line) was brought to the spot for comparison, and it was found that the turbine ship was brought to a stop in the water in slightly less time than that occupied by the engine-driven ship. I am informed that during the trials the turbines gave no trouble and their practical operation was entirely satisfactory.

Each turbine is built in the form of a drum-shaped shell built in sections, the shell having a length of about 11½ feet and an outside diameter of a little over 8½ feet, the reversing apparatus being all contained within the same shell. The weight allowed for each turbine was 70 tons and the actual weight was 57 tons.

A very remarkable feature of the result seems to be the screw performance at the unusually high revolutions. Three or four pair of screws were tried before the desired result was obtained, the turbines originally having been intended to run at 600 revolutions. The characteristics of the screw we have not as yet ascertained and cannot, therefore, state them, but it would seem from the excellent performance of the propelling machinery as a whole that the screws must have been surprisingly efficient in their action, considering the fineness of pitch involved

Shop tests of the turbine to ascertain their H. P. economy had previously been conducted, the power developed being measured by a disc water brake with the following results:

With a boiler pressure of 12 atmospheres or 190 pounds abs. with dry steam and a vacuum of 28 inches the steam consumption per brake H. P. was 12.76 pounds at 600 revolutions and about 13.42 pounds at 500 revolutions.

The application of this type of turbine for driving electric generators has received an extensive development by the General Electric Company under the very able and energetic direction of Mr. W. L. R. Emmet, who early foresaw its advantages and who has introduced many new mechanical features in design and construction. One novel feature introduced by Mr. Emmet was the vertical shaft form. In this form the entire weight of the rotating parts, comprising the turbine wheels and the revolving field or rotor of the generator, and amounting in the larger sizes to some-

thing like 75 or 100 tons, is mounted on an oil or water step bearing, which really is not a bearing at all, but a fluid cushion support under pressure sufficient to carry the entire weight, without permitting metallic contact. The success of this bearing in the face of the criticism and predictions often made, has been quite remarkable. The total number of turbine units thus far shipped by the General Electric Company is about 290 and those on order about 200 more. These units vary in capacity from 15 k. w. to 8000 k. w., more than 60 per cent of them ranging from 500 to 8000 k. w.—*Nautical Gazette.*

M. LOCKROY ON THE LESSONS OF TSUSHIMA.—M. Lockroy, like other critics, finds fault with the Russian admiral's dispositions, which, however admirable for the purpose of navigating the straits, were quite unsuitable for battle formation, their only result being to form the Russian fleet into an enormous target, some part of which every projectile from the enemy was able to penetrate, and which was incapable of being maneuvered without falling into disorder and confusion. He draws attention to the fact that, owing to the state of the weather, had the Japanese been able to watch the straits with nothing more than their torpedo-flotillas, Rojdestvensky and his fleet would certainly have got safely through. The nervousness of the Russians was shown by their opening fire at so great a distance as 10,000 yards, a range at which it could not be effective. Their shells also were defective, many burst badly, or did not burst at all; but this was not the fault of those in charge of the ships; it was the fault of the bureaucracy, and nobody who knows that bureaucracy will be astonished at any act of culpable negligence of which it may have been guilty. The Japanese, complete masters of themselves, reserved their fire until within 6000 yards, gradually closing to 3000, the range at which formerly it was considered advisable to begin an action. In an hour, the fate of the day was practically decided, and four of the most powerful vessels of Rojdestvensky's fleet, the *Borodino, Alexander III, Kniaz Souvaroff*, and *Navarin*, were engulfed by the sea. "The first despatches," remarks M. Lockroy, "reported that the ships sank, but it is now known that they capsized, which is a very different matter"; and he attributes the catastrophe to faulty construction, and to the lesson from the loss of the *Victoria* not having been taken to heart.

"Rojdestvensky himself," M. Lockroy continues, "was in no way to blame for the faulty design of his ships. He appears to have been a good seaman, but not a fighting one. More preoccupied in measures for furthering his voyage than in preparation for fighting, he had filled up his battleships to their utmost capacity with coal, beyond their ordinary stowage. Naturally, the ships thus overloaded rode deeper in the water, so much so, that the armor belts were almost completely immersed. This excess coal was placed wherever it was possible to stow it, both on the armor and upper decks. As the fires were supplied from the lower bunkers, there was a diminution in the lower weights in the ship, with an increase in the upper, resulting in a displacement of the center of gravity, which further tended towards helping the capsizing of the ships.

"With regard to these four ships there is no doubt as to what happened, but with regard to the fate of some of the others full details are still wanting. The part played by the destroyers and torpedo-boats does not seem to have been so important as at first made out. When the wind and sea fell, they came out and attacked ships already disabled or *hors de combat*. No submarines were used, as was at first reported, for the good reason that the Japanese cannot as yet work those they have.

"This tragic battle is full of lessons of different kinds. Leaving on one side, for the moment, questions of strategy and tactics, it shows, in the first place, by the annihilation of the principal Russian force in less than an hour, the superiority of fleets whose crews, like that of the Japanese, have been thoroughly trained in the working of their guns, and their

officers in the handling of the ships. It shows how foolish and criminal was the action of our late Minister of Marine in suppressing the Grand Naval Maneuvers, and condemning our squadrons, to an enforced idleness. It is only by steady and assiduous training that the men can acquire *sang-froid* and confidence in themselves. The seamen of the capsized ships fought heroically, but their bravery was of no avail, as they were not 'trained.'

"The famous armor belt afforded no protection. It was submerged. We won't speak of it. Recent events have shown that, as I have pointed out in my previous letter, it is necessary to armor the upper parts of the ships, since the ships being considered a large target, the part least exposed to being struck by projectiles is the water-line. The holes made in the ship's side, above the armor deck, tend to the capsizing and loss of the ship. That is the true danger as the Russian catastrophe shows. One can do something to lessen the danger by multiplying the compartments. But an armor protection of the upper works is necessary. This has been already recognized by England in the *King Edward VII* class.

"The gun still remains the most powerful weapon in modern battles. This is the most important lesson to be drawn from the battle of Tsushima, and throws a new light on the controversial problem of naval tactics. The events of that battle have shown that for the future naval battles will be fought at distances, which formerly nobody would have considered possible, and that this will necessitate a modification and rearrangement of the principal offensive force of ships—that is, the guns. I will not say a revolution is necessary; that is too strong a word. But I can affirm that at a moment when we are drawing up a new building programme, a further evolution has become indispensable. It is taking place in all foreign navies. It must not be believed that the long-range actions has been a fortuitous accident, which the future is not likely to see repeated. No. On reflection one is forced to the conclusion that it is the result of the present state of things, and the inevitable consequence of accomplished progress, and the successive improvements which have been realized in the *matériel*.

"It is an axiom recognized by all seamen, and which has become almost a common-place, that when two enemies meet, the one who first succeeds in crushing the other by his fire has obtained a success, which is generally decisive. This was Togo's leading idea in both the battles he fought, presumably also it was Rojdestvensky's when he opened fire before he was really within range. The necessity of striking before being struck oneself will necessitate fire being opened as soon as ever it will be effective, and in view of the formidable increase in the range of modern guns, this will be at a distance of some four miles, as in the battles of the 10th August, 1904, and Tsushima. The more the guns gain in ballistic power, the less will enemies be tempted to approach each other.

"It would have been difficult, however, up to a few years ago, to have fought a long-range action, no matter how powerful the guns may have been. It is the discovery of smokeless powder which has extended the field of battle and rendered Togo's exploits possible. Thanks to it, gunners can see clearly, and the effects produced by their fire can be noted, and it is possible now to correct the aim and regulate the fire with accuracy, however small the target may seem to be, so long as it is visible above the horizon, which was not possible, so long as ships, as was formerly the case, were enveloped in a dense veil of smoke from their own guns. Science and industry are not permitting us to fight long-range actions, but are compelling us to do so. And it is in view of long-range battles that our ships in the future must be designed.

"Herein lies the gun problem, for the ship is simply a floating gun carriage. The principal personage on board, I repeat, is the gun. With long-range battles it is necessary that the gun-carriages—called battleships and cruisers—should be able to carry more powerful guns than the greater

part of those with which they are at present provided. The gun to be what we call *effective* should be able to pierce at distances of from three to seven thousand yards—the ranges at Tsushima—the upper armor of the new foreign battleships, without taking into account the armor belt, which is never reached. The greater part of our guns at present in use are not capable of doing this."

M. Lockroy then points out that the guns in the secondary batteries of the new French battleship of the *Vérité* class, even those of them armed with the 7.6-inch guns in place of the 6.4-inch, are incapable of piercing, not the water-line belt, but the armor of the *King Edward VII* on the side above the belt, so that she is invulnerable except to the four 12-inch guns; on the other hand, the *King Edward VII* carries four 9.2-inch guns, in addition to her four 12-inch, with which she would be able to destroy the French ships at ranges when their secondary armaments would be quite useless."

M. Lockroy thus sums up:

"The conclusion to be arrived at is that we must resign ourselves to the almost complete disappearance of the secondary battery; this is the evolution of which I spoke. It is necessary that we should only mount on our floating gun-carriages guns which are able to pierce armor at distances of from three to six thousand meters. These guns exist, and are the 240-mm. (10-inch). They are very similar to those with which the *Kink Edward VII,* and those with which the new Japanese battleships are armed; and in all navies they are increasing in number on board vessels of war. This tendency is general and is warranted by facts. These guns have the advantage over the smaller ones in that they are armor-piercing, which the others are not; they have this superiority over those of greater caliber, that they can be fitted as quick-firers By the continuity of their fire they have the qualities of the medium-sized gun; by their power those of the heavy. A ship armed with 240-mm. guns in sufficient numbers is infinitely more formidable than a ship armed with a large secondary battery of medium-sized guns, and four very heavy guns, like the ships we possess at present. If for no other reason, the unity of caliber is an enormous advantage. War is so infinitely complex a business that we must, whenever possible, simplify the instruments with which it is waged. What confusion—it may, perhaps, be not too much to say what disasters—may not diversity of ships, diversity of guns, and infinite diversity of projectiles lead us to! The ideal should be, *a single type of projectile, a single type of gun, a single type of ship."—Le Yacht, Le Temps,* and *Le Moniteur de la Flotte.* (Translation from the *United Service Institution.*)

A Japanese correspondent favors us with some details about the *Iwami,* formerly the Russian *Orel.* It appears that though the upper works were blown to pieces, the ship, when she surrendered, was substantially unhurt and the story of the 150 wounded thrown overboard is pure fiction. About 32 men were wounded all told, and about half that number killed. One 12-inch gun had been broken off short, also one 6-inch, and the sum of real damage ended there. The ship will be doing her steam trials as the *Iwami* in the course of a week or two.

It is now definitely established that no Russian ships were sunk by gunfire in Port Arthur harbor, but that all were scuttled by the Russians. All machinery was carefully greased, the Kingston valves were then opened, and the ships settled down. The object of this was to reduce the target offered. It appears that the Russians expected Rodjestvensky to succeed in reaching Port Arthur in a crippled condition after a partial victory. The submerged ships were then to have been raised, comparatively little the worse for the Japanese land bombardment This, at least, was the apparent plan. General Stoessel's surrender, of course, upset it. Whether Rodjestvensky would have reached Port Arthur is another ques-

tion; on the whole, he would probably have got some ships in, as Togo's task would have been far more difficult than at Tsushima.

It further appears that the Russian Baltic fleet was amply supplied with all stores and ammunition, and an examination of the *Orel* shows that the story about defective armor will not bear examination. The armor was quite good. There is now no doubt that the lost vessels got into difficulties through water invading their lower decks, and finally sank in most cases from torpedoes, which seem to have been fired literally by the score.—*Engineer.*

CARE OF THE WOUNDED IN NAVAL WAR.[1]—To recapitulate, then, the active work of hospital-ships and of attending to the wounded commences directly the battle is over, at which time there will be an enormous amount of work for the small craft belonging to these vessels, if they wish to save men from sinking ships, that have in all probability lost their own boats.

One thing is certain, nothing could be more out of place than a hospital-ship in the confusion of battle.

It will be sufficient if we merely indicate the difficulty of transporting the seriously wounded from one vessel to another. A hospital-ship demands, in every case, an exceptional personnel, which, independently of the knowledge required for tending sick and wounded, should possess in a high degree sailor-like qualities. We feel confident we are not asking too much, and that all will agree as to the advantages of such qualifications, and hope that no question of expense will be raised.

Let us now pass on to the investigation of what can be done on board for the wounded, whilst the battle is still raging. The usual "hospital-of-combat," that is, the station for the wounded during "general quarters," ought to be placed entirely at the disposal of the injured while fighting is in progress. The exigencies of air and light can only be satisfied at the sacrifice of protection, by placing the wounded in an unprotected quarter of the ship.

The only situation that we can entertain as a dressing station during battle, is one beneath the protective deck. Both wounded men and the medical staff would be well sheltered from the effects of shell fire, though naturally they still remain subject to any of the grave catastrophes to which the ship is liable. What a prolonged stay beneath the armored deck means, when all boilers are in use and all hatchways closed, and when—a likely enough contingency too—the electric light fails, the reader may be left to imagine. Nobody would wish to maintain, we think, that such a place is an ideal one for wounded and dying men, who will soon pour in in such numbers that the space will be rendered quite inadequate. However, there is no alternative situation. As regards the translocation of the wounded on board, we must remember, above all, that the various apertures in the protective deck will only be open during some of the interregna of battle; for the most part they will remain closed in order to ensure the supernatant condition of the vessel.

He only who thoroughly appreciates the significance of that evolution which on board ship is known as the "transport of the wounded," can truly picture to himself the sufferings that a wounded man will have to endure. For in spite of every precaution, such a transport, involving risk to life, is inevitable, and justified only by the existing narrowness of circumstances.

Dressing-stations, located within a casemate or inside turrets, are, in spite of the danger of gases or paucity of room, safer than those on the upper deck. Hence our custom of acting on the principle, that during real battle, there can be no transport of the wounded or dead.

[1] Extract from an article by Vice-Admiral D. Paschen, I. G. N.

These will simply be placed on one side, the wounded, with an emergency dressing, which, according to circumstances, will have either been self-applied or put on at a favorable opportunity by comrades. During a lull in the fighting, the surgeon will hasten on deck, in order to ascertain who are to be taken below and who are to be left lying *in situ*.

For this reason, we recognize the indispensability of assuring the instruction of practically the whole crew in the manipulation of the seriously wounded and in the application of first aid dressings and bandages, etc., for the arrest of hæmorrhage.—*United Service Institution.*

SPEED AS A FACTOR IN NAVAL WARFARE.—In the *Moniteur de la Flotte* of September 23 appeared an article by the well known naval expert, M. C. Pierreval, which is worthy of attention. At the present juncture, when the French Parliament is about to consider a somewhat ambitious scheme of naval construction, discussion upon the type of vessel best suited for the necessities of naval warfare is even more animated than usual. It is five years, he writes, since the last great scheme of construction was laid down. During that period the greatest naval campaign of modern times has taken place, a large number of minor engagements, and two battles of "epic" proportions have been fought, and it might be supposed that many disputed points would have been definitely decided.

As it happens, the case is otherwise, and in particular the great controversy upon the speed question continues to rage with all the vigor and uncertainty of yore. "Look at the battle of August 10," say the partisans of high speed. "Had Admiral Withoeft possessed but an extra couple of knots he could have made good his escape, and reached the shelter of Vladivostock." "Do not forget Tsushima," reply the advocates of armor and armament. "Of what use was the 18-knot speed commanded by Rodjestvensky's best ships? Had he possessed in their stead 16-knot vessels, better armed, better protected, better supplied with stores, these would for the same tonnage have had a force much superior to that of the hostile fleet. Japan would have lost her ships, and with them the command of the sea."

Both parties, says M. Pierreval, have made concessions. The advocates of powerful ships have raised their speed limit from 16 to 18 knots, the party which believes in high speed have lowered their demands from 24 to 21 knots.

Thus it is a question of three knots that is now debated. An advantage of three knots may be lost in a moment through deficiency of fuel, damage to a boiler, delay in carrying out a maneuver. But three knots, on the other hand, means raising the displacement to 18,000 tons, and it implies an addition of 10,000 horsepower.

It happens, too, pretty generally that ships cannot attain their trial speed. Togo's squadron on August 10 reached but 14 knots against the 13 of the Russians, and some effort should be made to so improve the conditions of naval construction that the speed obtained in practice may more nearly approach the maximum of the official trials.

The writer goes on to conjure up a hypothetic battle in which two fleets, of similar numbers and tonnage, are opposed to each other, the fleets being only distinguished from one another by the fact that each vessel of one side is superior to the other by 3 knots of speed, but is inferior by reason of the loss of armor and armament which this extra three knots involves. Under such conditions the position of the faster fleet would, he thinks, be very critical, inasmuch as damage to a single ship would entail a falling off in the speed of the whole squadron, unless the admiral in command could bring himself to leave his lame duck to its fate.

"That is why," M. Pierreval writes in conclusion, "when the question is asked if a gain of three knots would compensate for the loss of three guns, and the question was definitely stated in this form the other day, it would seem that we cannot answer it without taking into consideration

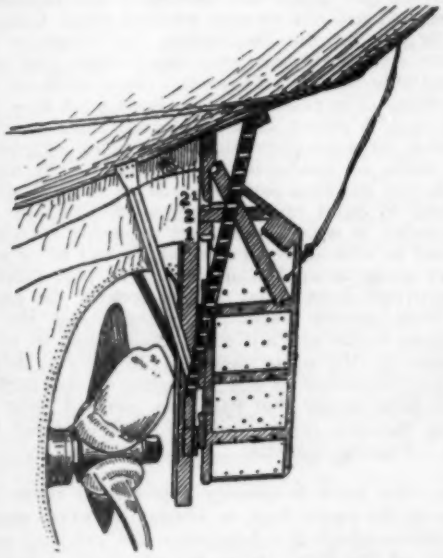
not only the absolute material loss of power, but the uncertainty and the liability to sudden deprivation of the advantage in speed."—*United Service Gazette.*

THE SPEED OF DESTROYERS.—Naval officers are taking a keen interest in the new experimental destroyer for the navy, which is to have a speed of 36 knots. Some eight or nine firms tackled the problem, and the results, if fully disclosed, would undoubtedly be of considerable interest. The destroyers, as designed, naturally vary considerably in size and also in cost. The Admiralty laid down certain conditions in addition to the speed, with special reference to the load of coal to be carried on the full-speed trial, the armament, and the ammunition arrangements; and sound finance suggests that the attainment of these onerous requirements at the minimum of cost should be the chief aim. The largest boat is about 30 per cent heavier than the lightest, and the price is almost correspondingly higher. Efficiency must be the determining factor, and the one point which would justify a higher expenditure would be greater sea-keeping qualities, which again are dependent upon strength and weight of scantlings. As one of the members of the recent Admiralty Committee on the strength of destroyers stated the other day, if the lighter boats are insufficient in strength to perform the duties demanded, then the money spent on their construction would be wasted. But is there such inadequacy to meet the probable stresses as ascertained by the committee? That is the point upon which he was not willing to express an opinion. Length in all cases has been minimized, although greater latitude in this dimension would have made it easier to get the speed; but with a long boat there might be an intensification of the hogging strains when the vessel was riding on the crest of waves and of the sagging effects when between waves owing to the bow and stern being on the crests.

Increased weight requires for a given speed greater driving power, and an augmentation of the space required for machinery. This would minimize cabin and other accommodation for officers, and, as Lord Charles Beresford pointed out quite recently, the comfort and the physical condition of the crew are important elements in the success of "destroyer" actions. While, therefore, it is most desirable to have adequate strength, it is equally important to attain the result without unnecessary margins of weight in scantlings. True success in naval architecture, as in all scientific practice, is to attain required results with such a precision as to eliminate any chance of weakness or strength over that demanded by the conditions. It ought to be possible to check theoretically the strength of designed scantlings, or, if not, guarantees might be saught from the responsible designers and builders. The 30-knot destroyers were needlessly discarded in favor of 25½-knot craft because of excess in weight, and it would be a mistake to forfeit any advantage in the new vessel on this score. The destroyer is to be experimental; experiments involve risks of failure, and it would, therefore, seem feasible to attempt the speed on a fair factor of safety in strength. Only by this means can future scientific progress be ensured.

As regards the speed of torpedo-boat destroyers, it will be news to a good many that the only measured mile over which the speed of our latest 25½-knot vessels can be properly tested is that at Skelmorlie, on the Clyde. If this is a triumph for Scotland, it also means that the builders of destroyers in other parts of the United Kingdom are put to considerable expense in taking their boats to the great northern river for official and other trials. At present, however, they cannot do anything else, as on no other measured mile is there a sufficient depth of water for the purpose of demonstrating the real rate at which these formidable craft can travel. A fortunate disappointment led Messrs. Yarrow, the well known builders on the Thames, to make a most valuable series of experiments. They had contracted to build a number of the latest 25½-knot

boats, and when the trials were made on the Maplin mile off the mouth of the Thames, the contract speed was not reached. Messrs. Yarrow then tried the craft in deep water over a mile near Dover, where the destroyers easily accomplished all that was expected of them. Similarly, at Skelmorlie—which, on no less an authority than Sir William White, is the only satisfactory mile for high speed trials—one of Thornycroft's destroyers went a knot faster than on the Maplin mile. It is now proposed to have a deep-water measured mile off the Goodwin Sands, and though that locality has not the best of reputations, from a navigable standpoint, surveys tend to show that there exists in the vicinity of the East Goodwin lightship ample depth for getting reliable data of trials of the fastest of vessels. Another point, distinctly humbling to our pride as the greatest shipbuilding and shipowning nation in the world, is that when it became necessary to undertake preliminary investigations regarding the design of these new destroyers, Messrs. Yarrow found that there was no tank in this country available for such a purpose, and had consequently to apply for



JURY RUDDER ON STEAMER NIGERIA.

the use of the North German Lloyd tank at Bremerhaven. If this means that the tanks at Dumbarton and Clydebank—almost the only private institutions of the kind in the United Kingdom—were closed against Messrs. Yarrow, the one of two things appears desirable. Either all shipbuilding firms of any size ought to have tanks of their own as permanent portions of their establishments, or public tanks should be erected at the great centers of the shipbuilding industry.—*United States Gazette.*

UNIQUE JURY RUDDER.—Shipowners and others in England have been interested in the case of the rigging of a jury rudder to the stern of the disabled steamer *Nigeria*, belonging to the African Mail Steamship Co., and of her successful voyage home. The *Nigeria*, on a recent voyage, struck on the Farcados bar, on the coast of Africa, and, instead of floating over it, as is usual, for it is a bar that ships have to "jump," she remained bumping for several days. During that time, and while efforts were being

made to float her, the stern frame broke and the rudder carried away about the coupling, taking with it the after part of the stern frame. The massive hand-screw gear on the rudder head was smashed, and the top spoke of the wheel was knocked into the top of the wheel house.

Eventually the ship was got out of her dangerous position, taken up the river, and her stern hove up on the bank, the bow being ballasted and kept afloat with very little motion. The rise and fall of the water was about 4 feet. In this position Captain Toft and Chief Engineer Craigie got to work to prepare the ship for a passage home of over 4000 miles. The rudder and its fittings had completely gone, and the facilities ashore to forge or even make up material for a jury rudder were most meager, consisting solely of what could be obtained at the Niger company's stores. To serve as a stern-post two "channel" girders were used, these being bolted together and strengthened by a number of angled strips, lattice fashion. The whole was bolted at the top to the stern-frame, and as all the boring had to be done by hand, the task was no light one.

The lower part of this improvised stern-post was secured to the frames and shell by means of two ties or stays on each side. One of these sets of stays, as will be seen in the illustration, was fixed so as to take the forward and side strains thrown upon the rudder; the other set taking the headway and side strains. These ties were built up of single angle bars bolted together. The rudder was made of pitch pine blanks sheathed with galvanized ¼-inch plates, secured to angle bars which had been improvised as a stock, or main piece, the whole being secured to the portion of the original stock, or rudder-head, remaining. The manner of securing the rudder to the standing part of the stock is most striking, for there was little material to build upon. Intelligence, aided by angle bars and hard labor, succeeded in what might have appeared a hopeless task. The rudder was bound in with three braces, which had to be made out of old iron. The upper gudgeon on the original stern post remained, but three others were improvised from cargo derrick sockets, the pintles used being obtained also from derrick heels. Notwithstanding the nature of the work, the conditions under which it was accomplished, as to place, material, facilities, and men—for the white men suffered more or less from fever—it was done in a way creditable to any workshop in the world, as a temporary job, and the great praise that has been lavished upon the captain for safely navigating the ship home, and the chief engineer for his skill, is richly deserved.—*Nautical Gazette.*

MOTOR BOATS.—We have frequently referred in these columns to the approaching era of the motor boat as adapted to naval purposes, and now that the experiments which the Admiralty are carrying out with various designs of vessels of this class are so far advanced, it becomes more than ever certain that they are destined to play a part in the history of marine architecture. At the same time, we do not for one moment believe that the system of internal combustion will be applied to large vessels during the next decade, not, perhaps, for another quarter of a century. It took a good deal more than ten years to get the turbine engine to that condition which made it possible to try it in large vessels, and so to lead the way to its use in merchant liners and armored cruisers and battleships. That we may have motor torpedo-boats and even destroyers, in ten years time is possible, though far from certain, but that we shall have motor launches and picket boats at all the home ports and on board all the large vessels of the navy within that period seems almost assured. It stands to reason that these launches will not be of the kind of vessels that the cross channel racing boats have been, for stoutness of construction will be one of the primary necessities in the design of any vessels intended for the naval service. And the fact that all the principal shipbuilders in this country are experimenting with boats of this class shows conclusively that it is the

impression in professional circles that there is a future for the motor launch.—*Army and Navy Gazette.*

SUBMARINE SIGNALLING.—Another direction in which there has been a good deal of experiment lately, is in submarine signalling. The Trinity House officials in particular have carried out a long and severe set of tests off the coast of Kent, and, the results having been placed before the Admiralty, we may hear before long that the system is to be tried in the navy. Of course, on and off, experiments in this direction have been made during the past one hundred years, and in 1821, a M. Culladon claimed to have successfully transmitted and received sounds under water on the lake of Geneva at a distance of twenty-two miles. About fifteen years ago also, a company endeavored unsuccessfully to exploit the "aquæphone," experiments with which were of a fairly satisfactory character. In the Trinity House trials the maximum distance at which the sounds transmitted from the new submarine bell, which is provided with an extra thick lip, measuring 15 inches over the mouth, 11¼ inches in height, and weighing some 140 lbs., was sixteen miles, but it was found that three things had a marked effect upon the range of audibility. These were the size and draft of the vessel receiving the sound, the depth of the transmitters and receivers below the surface, and the relative positions of the vessels in communication. Some more wireless telegraphy experiments are to be carried out shortly also, and a third-class cruiser and some gunboats are being specially fitted up for the purpose. The difficulty still experienced in preventing the "destruction" of messages by interruptions from unfriendly transmitting offices, has not yet been overcome, and, until it is, the utility of wireless telegraphy for naval purposes cannot be said to be fully established.—*Army and Navy Gazette.*

SUBMARINE SIGNALLING.—The Cunard Steamship Company have five of their North Atlantic steamers, the *Lucania, Campania, Caronia, Ivernia,* and *Saxonia,* fitted with the submarine signalling apparatus, which has already been described and illustrated in this journal. By means of this apparatus the navigating officer is apprised of the position of the light-vessels in thick weather. The *Carmania,* the largest turbine-driven steamer in the world, and the first to run between Europe and the United States, will also be fitted. This vessel is announced to sail on her first voyage from Liverpool to New York on December 2d.—*Page's Weekly.*

DIRECTED WIRELESS TELEGRAPHY.—Early in July some experiments were conducted at Strassburg by Dr. Ferdinand Braun with a system of directed wireless telegraphy which he has invented. The results seem to him very promising, for he was able at will to direct the waves so as to actuate the receiver at the receiving station or not. Dr. Braun in several German journals discusses his experiments, and points out the probable usefulness of his developments.

Since electric waves are governed by the same laws as light waves, it should be possible to throw a beam in one direction by means of a parabolic reflector, but the practical difficulties in the way seem to be insuperable. It occurred to Dr. Braun, however, that he could construct a system of sending wires which could be made to intensify the wave in one direction and interfere with it in other directions. If two sending wires are tuned to exactly the same pitch and are operated by the same exciting apparatus, but are so arranged that one of them will be set in vibration a small fraction of a second later than the other, it should be possible to obtain interference. The difficulties encountered in doing this are those of tuning two oscillators to the same pitch, and of producing the desired difference in phase. New methods had to be devised for measuring these exceedingly small time differences. This has been done, but the method is not de-

scribed. Extended laboratory experiments resulted in the development of means of tuning the wires and for producing the difference in phase sought without throwing the two wires out of tune. In this work Dr. Braun was assisted by Dr. Papalexi, of the Strassburg Institute, and Dr. Mandelstam, who co-operated with him.

The laboratory results agreeing satisfactorily with the theory, it remained to test the system on a practical scale. Fortunately a suitable place for carrying out this work on a larger scale was available in the large drill ground at Strassburg, known as the Polygon, which was courteously tendered to the experiments by the military authorities. The investigations were carried out on a small scale as compared with wireless telegraph transmission systems, since it was desirable to obtain quantitative, and not merely qualitative, results. It was intended to measure the difference in intensity of the waves sent out in different directions, and for this purpose a relatively short transmission was advantageous.

The sending station consisted of three wooden masts arranged at the corners of an equilateral triangle. Upon each of these masts was stretched a wire or antenna, from the lower point of which a connecting wire was carried to a wooden building placed at the center of the triangle, in which are mounted the various sending devices. By means of the apparatus contained in the building it was possible to set the wires on posts 1 and 2 into synchronous vibration, and to set up a vibration of the wire on post 3 of the same pitch, but which lagged or led in phase the vibrations of the other two. Assuming the vibration of wire 3 to be slightly lagging, interference between it and that of wires 1 and 2 would take place in the direction from 3 over the house at right angles to the plane containing posts 1 and 2. This amounts to throwing an electrical shadow in that direction. If, on the other hand, the vibrations of wire 3 were made to lead those of 1 and 2 by a proper amount, an amplified wave would be sent out in the same direction, and a shadow thrown backward from wire 3, and at the same time, interference on the sides would take place. In carrying out this work it was necessary to obtain great accuracy in timing the vibrations of the three wires. The time difference was about one-ten-millionth part of a second. Dr. Braun concludes from his work that it is possible to adjust the time difference to within a two-hundred-millionth part of a second. This amounts to an accuracy of one second in six years.

This system of three masts is only a particularly simple arrangement, for more sending wires might be used with an augmented effect; but for the work in hand the simplicity of the system presented some important advantages. It should be noted that transmission is not limited to one direction only with three masts, for it can be sent in the reverse direction by reversing the phase relations. By alternating the function of wire 3 with that of wires 1 and 2 it is possible to transmit messages at will in six directions. The simple addition of a commutating switch in the sending station enables this change in direction to be made easily and at will. It was found that the receiving apparatus at a particular position responded without fail when this commutating switch was in one position, and yet showed no signs when the position of the switch was changed. The distance of the sending station was in these researches 1.3 kilometers.

The results of the experiments were completely in accord with the laboratory investigation and with theory. In other words, it is possible by means of this arrangement to direct a wireless message through a fairly narrow angle. Dispersion takes place and is not small, but there is a decided electrical shadow in the reverse direction, and there is, in fact, a wide angle in which no effect can be measured.

If the receiving station had been equipped for transmitting messages also, it would have had three or more antennæ, and there is no doubt that these wires could be used in an analogous way for increasing the effect at that point.

The use of more than three wires would enable the transmission to be sent out through a still smaller angle, with a less degree of dispersion; but it would complicate the system somewhat. The system as it is, with the three wires, is considerably more complicated than that having but a single wire, and the question is raised whether a parabolic reflector consisting of a number of wires properly arranged might not be employed with but a single oscillating wire at the focus. This is shown to be impracticable, since to be of any value with waves of the length of 120 meters, which is comparatively short, and therefore relatively favorable for this purpose—the sending wire should be about thirty meters from the reflector, and the latter should have an opening of about 120 meters at the focus. Moreover, this reflector should be extended many hundred meters at the sides in order to prevent dispersion. A reflecting wire placed at this distance from the sending wire occupies a very small angle, and hence would be almost useless as a reflector. It was found that the three wires, as used in the interference system, had no effect whatever as a reflector. Although there is no fundamental reason why this difficulty should not be overcome, there is the other objection that the parabolic reflector should be about a kilometer long to give results comparable with those obtained with the three-wire system described.

The Strassburg tests, in Dr. Braun's opinion, demonstrate that a directed system of wireless telegraphy is practicable. Five wires might be substituted, which would increase the action in one direction and give rise to less dispersion, but the three-wire system gives results as favorable as could be expected.—*Electrical Review.*

DAMAGES TO RUSSIAN SHIPS AT PORT ARTHUR.

The following report of the damages found to have been done to the Russian ships at Port Arthur is taken from *Engineering* of October 20, 1905. The 28-centimeter shell, which did most damage, were fired from 203-Meter Hill, at a distance of about four miles.

DAMAGES TO "PERESVIET."

Damages to Armored Deck.—Twelve holes appeared through the upper deck (reduced to 11 through main deck), made apparently by 28-centimeter shells. Of these, four continued down through the armored deck. All fell at an angle of some 30 degrees from vertical, direction forward to aft, and slightly port to starboard. The armored deck was pierced by shells: (1) Just before foremast; deck about 1½ inches thick; and plate under mast step torn, thickness apparently 1 inch. (2) A little more forward and towards starboard side of ship. (3) In passage on starboard side of boiler casing abreast of aftermost funnel. Shell had come through funnel and casing. Thickness of deck ½ inch + 1¼ inches = 1¾ inches. (4) A little more forward and towards starboard side, slope of armored deck pierced just above a coal-scuttle; thickness not more than ⅝ inch + 1¼ inches = nearly 2 inches.

Below the armored deck it was not possible at the time to penetrate; it is reported that none of the four shells above detailed made their way out through the ship's side. (5) Another shell struck the hurricane deck about 30 feet from the bow; went down through hurricane, upper, and main decks, and then met side of ship at level of lower deck. Here it either passed out or was deflected back into the ship; at any rate, it made the hole *D* found by the divers (see below). (6) Still another shell went through the hurricane and upper decks until it came into contact with the plating (1¼ inches) at rear of lower after casemate, port side. There it exploded and tore a large hole, some 3 feet by 3 feet, in the plating mentioned, and did not pierce the main deck. Three shells are reported to have been picked up unexploded. This accounts for six out of eleven shells that penetrated the main deck. The others were less easy to trace.

Effects of Bursting Shells.—In the case of shell (6) just mentioned, the damage done by the explosion is easily seen. In other cases the wreckage done to the structure by the bursting of large shells seemed not very serious. The same remark does not apply to smaller shells; in the *Peresviet*, and perhaps more in some of the other ships, the upper structures, funnels, casings, deck-houses, etc., are riddled with holes and tears of all shapes and sizes.

Effects of Fire (*Conflagration*).—The hurricane deck of the *Peresviet* (steel sheathed with wood) has the wood destroyed by fire for some 60 feet below the foremast and forward barbette, and 40 feet near the after bridge; in both cases the full breadth of ship. It is suggested that the Russians had smeared the decks with kerosene, and set fire thereto. This vessel is by far the worst damaged in this respect; *Pobieda*, which comes next, having only some 30 feet length of deck destroyed.

Holes Reported by Divers.—Damage to side armor cannot at present be examined; if it exists, it is entirely below water. The holes reported by divers lie below the armor shelf, (D) indeed excepted. (A) Hole, 3.5 meters deep by 2 meters long, port side, top about level with armor shelf, center slightly abaft the after end of the forward casemate. The diver reports this as formed from without. (B) Smaller hole, port side, a little farther forward, beneath forward barbette. (C) Hole, 2.5 meters long by 0.5 meter deep, about 3.5 meters below normal draft of water, starboard side, nearly abreast of aftermost funnel. (D) The hole caused by shell (5) mentioned above. The 10-inch gun-turrets, both the forward and the after, were damaged by explosives placed inside; the heavy plates displaced somewhat, and joints open from this cause.

DAMAGE TO "BAYAN."

Damage to Protective Deck.—So far as could be found, three 28-centimeter shells had penetrated the protective deck: (1) In the after-cabin, just abaft the break in protective deck (it drops to some 3 feet below lower deck); angle of plunge, about 30 degrees off vertical; direction forward to aft, about 3 feet off center line of ship, starboard side. Thickness of deck, about ⅜ inch + 1 inch = 1⅜ inch. (2) Abreast of No. 4 boiler casing (numbering from forward). Angle about 15 degrees from vertical, direction forward to aft, and slightly port to starboard. Shell entered side of ship just below upper deck, penetrated main deck, and then protective deck about 3 feet in from side of ship. Thickness of deck apparently 1 inch (probably 1 inch + ⅜ inch = 1⅜ inches). (3) Just above intermediate cylinder of starboard engines. The shell entered upper deck at or near center line; angle 20 degrees or 30 degrees to vertical; direction forward at aft, port to starboard; hole in protective deck about 6 feet off center line. Thickness of deck, ⅝ inch + 1 inch = 1⅝ inches. Shell smashed the top and side of cylinder; exploded shell said to have been found in crank-pit.

Damage to Armored Side (*above Water*).—(A) The upper strake of the 3-inch plating (¾ inch + 2¼ inches) forward, port side, was struck at the bottom edge, some 25 feet from the bow; the 2¼-inch plates are fastened to the ¾-inch from inside by tapped screws, about 1⅛ inches in diameter under thread, ½-inch pitch. The bolts have no head, but are screwed up by a screw-driver notch on the end. The 2¼-inch plate struck by the shell was shattered. The hole was 3 feet wide. The concussion has caused the 2¼-inch plate below (second plate on port bow, in second strake from the top; the bottom of this strake about 3 feet above normal water-line) to draw its fastenings, stripping the threads of the screws in the ¾-inch plate; some obstruction holds the plate from falling, and it lies at present in place at the lower edge, 18 inches from the side at the upper edge, with an outward inclination.

(B) Upper and lower strakes of 3-inch plating (¾ inch + 2¼ inches) in way of engines, starboard side, driven in. The damaged portion is fully 20 feet long; the depth extends from the protective to the main deck (and rather more, main-deck stringer being curved upwards).

(C) *Other Damage.*—Communication-tube to conning-tower (2 feet inside diameter, 3 inches thick), shattered from upper deck to main deck, apparently from starboard side. Possibly the shell entered the starboard casemate. (D) Unarmored side (starboard) in way of after cabin (just abreast of hole *I*), blown in for a length of 20 feet, and depth from protective deck to above main deck. Bulwark on starboard side shattered in two or more places. (E) Just abaft after gun-house, for a length of 30 feet, and full breadth of ship, the upper deck is torn up, apparently by explosive placed in 'tween decks by the Russians.

DAMAGE TO "POLTAVA."

Three holes visible in upper deck, apparently made by 28-centimeter shells. The divers report only one large hole below water (under armor), 6.2 meters long by 2.8 meters deep, on starboard side between funnels, but nearer after funnel; top of hole at armor shelf. Hole made from outside.

DAMAGE TO "RETVISAN."

No large holes at present exposed on the decks that are to be seen. Plenty of smaller holes by perhaps 6-inch shells or fragments. The divers report the following holes, below armor, port side, made from outside: 3 meters by 3 meters, 2.4 meters by 3 meters, 3 meters by 3 meters, 2 meters by 1 meter.

DAMAGE TO "POBIEDA."

Three or four holes in upper deck, on both port and starboard sides. In this ship there seems less regularity in the direction from which the large shells came than in the other ships. The direction of two was roughly from E. by N. to W. by S., as ship now lies; one shot passed nearly horizontally through a casing; some of these could have struck the ship in her present position; swinging with the tide might account for the two, but the horizontal shot must be traced to a date earlier than December. Foremast was struck just at level of top of conning-tower; it lies now, roughly at right angles, across starboard side of the ship. Fire has destroyed some 30 feet in length of wood (over steel) of upper deck—full breadth of ship—just abaft forward barbette. The divers report one large hole, 8.5 meters by 4.5 meters, in port side below armor in way of engine-room; also smaller holes. One of these smaller holes, however, appears to be through the 4-inch armor on the starboard side forward; all made from outside.

DAMAGE TO "PALLADA."

On upper deck there were found six large shot holes, starboard side; one large shot hole, port side; direction, about aft to forward.

Other Damage.—(*a*) Upper deck aft under capstan blown up, full breadth of ship, for 50 feet or so from stern; worse on starboard side, where a slit of about 10 feet in length exists, the edge of plates and planks at the slit being thrown up some 4 feet from normal. Looking below, it appears that the main deck plating was turned up to the level of upper deck; main-deck beams twisted and bent in all directions, tearing frames from the shell on the starboard side of the ship. The source of the explosion was evidently somewhere below the main deck (which at the time of observation was awash on starboard side, and some 4 feet below water on

port side). (A) Below *A* on starboard side, and starting from water-level at main deck, a triangular-shaped hole could be seen, widening as it got deeper. (B) Dynamo-room on upper deck between funnels 2 and 3 (counting from forward), and just in front of funnel 3, wrecked by explosion from within.

The divers report the following holes, all on the starboard side, and made from without: 8 meters by 5 meters—the rent *A* above; 3 meters by 3 meters, just abaft boiler; 8 meters by 4 meters, forward.

Damage done by the Russians to the above Ships.—Those who have the salvage work in hand attribute the following to the agency of the Russians in their attempts to render the ships unserviceable in the future: (1) All the holes below water (for some reason the holes below water in the *Peresviet*, or some of them, are not attributed to the Russians, but to Japanese fire; the distinction thus made is not sufficiently explained). In some cases torpedo-heads were found attached to the sides of the ships, evidently with the intention of causing damage. It is not understood that any damage is attributed to this cause, the attempt to employ this means having apparently proved futile. Gun-cotton is supposed to be the explosive that was used effectively (by the Russians) to cause the damage actually found below water. (2) The damage to turrets of the *Peresviet*. (3) Damage *E* in *Bayan;* possibly also damage *B* and *D*. (4) Damage *AA* and *B* in *Pallada*. (5) Fire on deck of the *Peresviet*. In the *Peresviet* some dynamite cartridges were found in the after magazine, and wires led thereto, evidently with the intention of exploding it. In no case, however, was a magazine successfully exploded.

Stranded Ships, etc.—At the entrance to the harbor were five ships on the beach, and about twelve besides; in the latter cases sometimes masts only, sometimes funnels, or funnels and davits; sometimes the side of the ship (lying on her beam ends) was visible. Some thirty-five in all are said to be there. In the west harbor lay about sixteen large steamers stranded or grounded in shallow water. There are four dredgers (two of these, indeed, afloat) of the ordinary bucket arrangement.

INTERFERENCE IN WIRELESS TELEGRAPHY.[1]

Of the various problems which have been presented in the course of the development of wireless telegraphy none is of greater interest to the engineer, and none is of more far-reaching importance from the industrial and commercial standpoint, than that of rendering the receiving instruments of wireless telegraph stations immune from interference. The simplest solution of this problem is to cause each transmitter to send out its signals by means of persistent trains of simple harmonic waves of a frequency materially different from that employed by any other transmitter within operative range of the receiving station with which communication is to be maintained, and to make each receiver responsive only to persistent trains of simple harmonic waves of the frequency employed by the transmitter with which it is in communication. By this means the system is rendered selective and becomes a multiple system of telegraphy, permitting the operator at each station to select the station with which he wishes to hold communication to the exclusion of all the other stations. A number of messages may thus be transmitted simultaneously in a given region without interfering with one another.

Since the stray electromagnetic waves arising from lightning, etc., are not persistent trains of simple harmonic waves, but partake more of the character of isolated impulses, the receiver in such a system does not respond to such stray electromagnetic waves, and it is, therefore, also freed from interference which would otherwise arise from such sources.

[1] Abstract of a paper by John Stone Stone, read before the Canadian Society of Civil Engineers.

The manner in which a transmitting station is made to develop persistent trains of simple harmonic electromagnetic waves of one frequency to the exclusion of waves of other frequencies, though simple in itself, in practice requires the strictest attention to certain details, and these may be best understood by the consideration of a concrete case, this being the manner in which these problems are usually presented to the engineer if not to the inventor.

The vertical oscillator in general consists of two parts, the elevated conductor *per se* and the devices through which it is connected with the earth. We shall here consider the relative simple case in which the elevated conductor is a straight cylindrical copper wire of length a and radius ρ. Both theory and practice show that the electrical vibrations in such a wire connected directly to the earth at its lower extremity correspond very closely to the transverse vibrations of a heavily-damped stretched string. If such a wire be charged to a high potential and be then permitted to discharge to earth, the electrical oscillations developed in it, and therefore, also, the electromagnetic waves radiated by it, will not be simple harmonic in type and will not be persistent. These waves will not, therefore, correspond to the sound waves given out by a tuning fork, but will be of the character of those given out by a heavily-damped violin string plucked at its center.

The fundamental of the waves given out by such an oscillator has a wave-length which very closely approximates four times the length of the wire, and this is accompanied by all the odd harmonics. The oscillations are so much damped by the energy drawn off from the oscillator by radiation as to make the resulting waves more nearly the equivalent of an impulse than of a sustained or persistent train of waves. If, however, the elevated conductor be not directly connected to the earth, but be connected to it through an inductance coil, both theory and practice show that its electrical vibrations correspond to the transverse vibrations of a heavily-damped stretched string with a mass attached to its center. The effect of the load at the center of the stretched string and of the inductance at the base of the vertical wire is to increase the persistency of the vibrations, to minimize the importance of the harmonics, and to lower the frequency of the fundamental. It might, therefore, seem that in order to cause the vertical oscillator in question to radiate a persistent train of simple harmonic waves of a predetermined frequency, it would be sufficient to charge the vertical wire to a high potential and permit it to discharge to earth through an inductance coil of suitable dimensions. This, indeed, was the plan adopted in the first crude attempts to produce a selective system of wireless telegraphy; but it necessitates the use of waves of much lower frequency than that normally produced by natural vibrations in the vertical wire *per se*.

The degree of persistency of oscillations so obtained, however, is not as great as is required in practice. Such persistency as is obtained is gained at the expense of the amplitude of the current oscillations in the vertical and at the expense of the radiating power of the oscillator, the latter being *cæteris paribus* less for low than for high frequencies. Moreover, the spark in the vertical oscillator which normally dissipates an undue amount of the energy of the oscillations, has its resistance enhanced by the reduction of the amplitude of the current oscillations due to the presence of the inductance coil. This latter difficulty may in a measure be overcome at the expense of any increase of the energy supplied to the oscillator, by shunting the spark-gap by a condenser of large capacity. The discharge of the condenser across the spark-gap increases the current through the spark and thereby reduces its resistance and damping effect upon the oscillations. The damping effect of the radiation still remains, and the persistency is still too much limited for practical purposes.

So far we have considered only the natural oscillations of the vertical oscillator which are produced by charging the elevated conductor to a

high potential and then permitting it to discharge to earth. When, however, a high degree of persistency, a pure sine wave, and a great amplitude of oscillation are desired, the spark-gap is removed from the vertical oscillating circuit and a simple harmonic E. M. F. is impressed upon the vertical oscillator in its place. The resulting vibrations in the vertical oscillator are then forced simple harmonic vibrations. In order that they may be of great amplitude the frequency of the impressed force is made to correspond to the fundamental of the vertical oscillator or to one of its harmonics, in which cases the reactance of the vertical oscillator is nil.

A simple arrangement for producing forced, simple harmonic vibrations in the vertical oscillator is shown in Fig. 1, in which G is an alternating-current generator, K is a key, P shows the connection to the terminals of the primary of a spark coil, S is a spark-gap between the terminals of the secondary of the spark coil, C_1 is a condenser, L_1 is an inductance, I_1 and I_2 are the primary and secondary coils of a high-frequency transformer, and E is the earth.

For the type of elevated conductor which we are here considering—i. e., a cylindrical copper wire of length a and radius ρ—the reaction of the

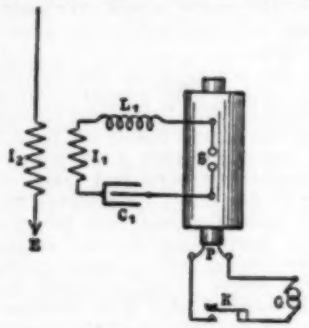


FIG. 1.—ARRANGEMENT FOR PRODUCING FORCED SIMPLE HARMONIC OSCILLATION.

elevated conductor *per se* is given with a degree of approximation ample for engineering calculations by the expression:

$Z = Lv \cot \frac{na}{v}$ where $L = 2 \log_e \frac{4a}{\rho} - k$, and where $k = 5.584 - 3.169 (na/v)^2 + 0.3269 (na/v)^4$ for values of a between 0 and $\pi v/2n$.*

In these expressions, v is the velocity of light and n is the periodicity of the impressed force or $2\pi/T$, where T is the time of a complete oscillation. The reactance Z therefore vanishes when $n = 2\pi/T = (m\pi v/2a)$, where m is an odd integer. The wave-lengths corresponding to this condition are therefore $\lambda = v\,T = 4a/m$. The wave-length of the fundamental is therefore $4a$ and the harmonics are all odd.

For frequencies lower than that of the fundamental, the reactance is negative or a capacity reactance. For frequencies between that of the fundamental and its first harmonic the reaction is positive or an inductance reactance. For frequencies between that of the first even harmonic and the first odd harmonic the reactance is again negative or a capacity reactance. In other words, the reactance of the vertical wire measured at the

*The value of k here given has been determined empirically, the remainder of the formula being based upon a theoretically deduced working theory described in the paper referred to. A more complete expression for L will be given elsewhere.

source or driving point of the system is either that of a condenser of capacity $S' = \frac{1}{Lvn} \tan \frac{na}{v}$ or of an inductance, $L' = \frac{Lv}{n} \cot \frac{na}{v}$ depending upon whether cot na/v is positive or negative.

The condition for zero reactance in the vertical oscillator system is obviously $Z + Z_0 = 0$ where Z_0 is the reactance of the apparatus connected between the vertical wire and the earth. Z_0 must therefore be an inductance reactance for frequencies which make the reactance of the vertical wire a capacity reactance and conversely it must be a capacity reactance for frequencies which make the reactance of the vertical wire an inductance reactance.

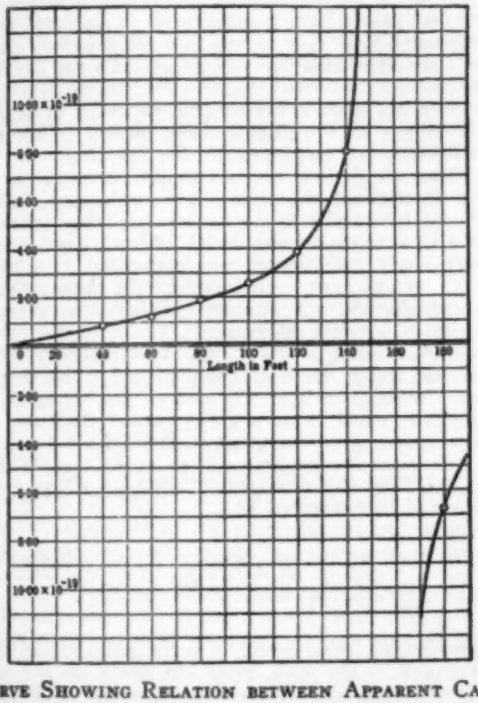


FIG. 2.—CURVE SHOWING RELATION BETWEEN APPARENT CAPACITY AND LENGTH OF ELEVATED CONDUCTOR AT PERIODICITY $= 9.78 \times 10^6$.

The curve shown in Fig. 2 gives the observer apparent capacity of vertical wires 0.08 inch in diameter, varying from 40 feet to 180 feet in length, when the periodicity of the impressed force is 9.78×10^6. In other words, it gives the observed apparent capacity of vertical wires for values the angle of na/v from 0.3976 to 1.790, and for values of the ratio $4a/\rho$ from 47,520 to 213,800.

The reactance Z_0 of the apparatus through which the vertical wire is connected to ground may most simply be made negative, when this is necessary, by the insertion of a condenser in series with the coil I_2, but this result may be accomplished in a variety of ways for the description of which there is not space in this paper. It will seem that by making $Z_0 = 0$ or Z_0 equal but opposite in sign to the reaction of the elevated conductor, powerful oscillations of any desired frequency may be developed

in the vertical oscillator by means of forced vibration, whereas when the natural oscillations of the vertical oscillator are resorted to, the frequency must necessarily be less than that of the fundamental of the oscillator.

Concerning the arrangement illustrated in Fig. 1, there is much of detail which requires attention in order that the apparatus shall satisfactorily fulfill the requirements of radiating a persistent train of simple harmonic waves. For instance, if a dielectric having considerable electrostatic hysteresis be employed in the condenser, a surprisingly large amount of energy will be dissipated in this dielectric. The magnitude of this loss is due to the fact that the energy dissipated increases both with the P. D. employed at the terminals of the condenser and also with the frequency. Since P. D.'s developed at the terminals of the condenser amounting to 50,000 volts and oscillations having frequencies of 5,000,000 are not unusual in wireless telegraphy, it is easy to see that the losses in the dielectric of a condenser in a wireless telegraph circuit are of a far greater order than that in the dielectric of condensers employed in the usual power or lighting circuits. Moreover, the specific inductive capacity of most dielectrics is a function of the density of the displacement current in the dielectric, and when such dielectrics are employed in the condenser in an oscillating circuit the resulting oscillations are not simple harmonic in form and are not isochronous throughout the train. Air condensers should, therefore, be used in wireless telegraphy to the exclusion of any other type.

The coils used in wireless telegraphy should not have iron cores except the iron be very finely comminuted and embedded in a non-hygroscopic dielectric matrix. It has even been found by the author that coils wound on a wooden cylinder do not operate satisfactorily when used in the oscillating circuits of wireless telegraphy. The coils for this purpose are best constructed by winding a few turns of bare copper wire in a single layer on a skeleton frame made of ebonite, care being taken to separate the turns by such an amount that the sum of the air spaces between the wires of the turns is equal to or slightly greater than the sparkling distance in air corresponding to the greatest P. D. liable to occur at the terminals of the coil when the apparatus is in operation. If the local oscillating circuit $C_1I_1L_2S$ of the arrangement shown in Fig. 1 were isolated, its oscillations would be expressed by

$$i = e\sqrt{\frac{S}{L}}\,\varepsilon^{-\frac{R}{2L}t}\,.\,\sin\frac{t}{\sqrt{LS}},$$

where i is approximately the current, e is the potential to which the condenser C_1 is charged at the time when the spark occurs at S, L is the inductance of the circuit, R is the resistance, and S is the permittance or electrostatic capacity of the condenser.

The time required to fall to $1/e$ of their initial amplitude is therefore $t = 2L/R$. The number of oscillations per unit of time is $1/2\pi\sqrt{LS}$. For a given frequency, $Ln = 1/Sn$, so that the persistency for a given frequency is proportional to Ln/R, where n is 2π times the frequency. The measure of the persistency of the circuit is, therefore, proportional to $\sqrt{LR^2S}$. An isolated circuit of this type may be made to give extremely persistent simple harmonic oscillations, but if it be given a large coefficient of mutual inductance with another oscillator of relatively low persistency, such as the vertical oscillator VI_2E of the arrangement shown in Fig. 1, two things happen. In the first place, the oscillations of the circuit are in general no longer simple harmonic, but are broken up into two simple harmonic oscillations of different frequencies, and in the second place the persistency is greatly reduced. To overcome this difficulty it is necessary either to make the magnetic leakage of the high frequency transformer,

connecting the local oscillating circuit with the vertical oscillator, unusually large, or else to add to the local oscillating circuit in inductance coil L_1 with sufficient inductance to swamp by its effect the reaction from the secondary circuit. When intense radiation is desired, it is necessary to make the capacity S of the condenser C_1 in the local oscillating circuit large compared to S^1, the apparent capacity of the elevated conductor *per se* for the frequency employed.

Since the electromagnetic waves to be received at a wireless telegraph receiving station are horizontally polarized at the earth's surface, an electrical oscillator whose axis is normal to the earth's surface is employed at the receiving station. This oscillator may either be connected to earth at its lower extremity or it may be connected to a device having reactance equal for all frequencies to the reactance of the vertical oscillator. It is to be remembered in this regard that at the receiving station we are not concerned with what becomes of the energy which is dissipated by the reradiation of the energy from the receiving vertical oscillator.

We shall consider again a simple concrete case, and shall assume the elevated conductor to be a cylindrical copper wire of length a and radius ρ as in the case of the transmitter, though it must by no means be assumed

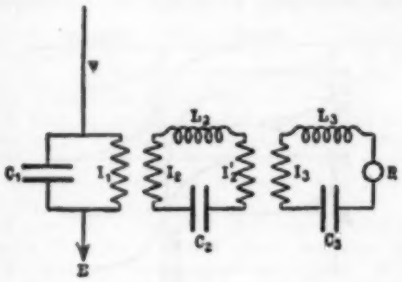


FIG. 3.—SELECTIVE RECEIVING CIRCUIT.

that the elevated conductor at the receiving station must necessarily be similar to that at the transmitting station, except in so far as its axis is preferably normal to the surface of the earth.

As in the case of the transmitting station, only one simple arrangement of the apparatus sufficient to give the desired result will here be considered. By this arrangement messages transmitted by means of persistent trains of simple harmonic electromagnetic waves of a predetermined frequency may be received to the exclusion of messages transmitted by similar waves of materially different frequencies, and without interference by impulsive waves. Such an arrangement of the circuits and apparatus is shown in the diagram, Fig. 3. In this arrangement the receiving device which is indicated at R is placed in a local circuit, $C_3I_3L_3R$, made resonant to the frequency of the waves to which the station is intended to respond, and a second resonant circuit, $C_2I_2L_2I_2$, resonant to the same frequency and called a "weeding-out circuit," is interposed between the first-mentioned circuit and the vertical oscillator. The branch circuit, consisting of the coil I_1 and the condenser C_1 is not, when taken by itself, resonant to the same frequency as the other local circuits, but is so proportioned that when connected as a branch circuit, forming a part of the vertical oscillator system, the latter shall respond most energetically to persistent trains of waves of that frequency falling upon the vertical wire. The way in which this is accomplished is perhaps more easily seen by a graphical demonstration than by the use of the analytical solution, though the latter is by no means difficult.

The curves in Fig. 4 illustrate the point in question. Curve 1 represents the reactance of the vertical wire measured at its point of attachment to the loop circuit, for varying periodicities of the impressed force. It will be seen that the periodicity of the fundamental of the vertical wire is at the point n_1'', where the reactance first vanishes. The first even harmonic is at n_2'', and the periodicity of its first odd harmonic is at n_3'', where the reactance again vanishes. Normally, therefore, curve 3, which is the current curve for varying periodicities of the impressed force on the vertical wire, would show maxima at n_1'' and at n_3''. The reactance of the loop circuit for varying periodicities of the impressed force measured across the points of its attachment to the vertical wire and earth connection is shown in curve 2. The total reactance of the vertical oscillator measured at the earthed terminal is the algebraic sum of the two reactances shown in curves 1 and 2, and as a result the current curve 3 shows maxima, not at n_1'' and n_2'', but at periodicities n, n'', and at a periodicity slightly higher than n_3''. These are the points at which the reactance of the loop circuit is equal, but opposite in sign, to that of the vertical wire. The periodicity of the local loop circuit *per se* is n_1' and for this periodicity the current in the vertical wire is practically *nil*.

The "weeding-out circuit" and the circuit containing the receiver are both resonant to the periodicity n, so that for persistent trains of waves

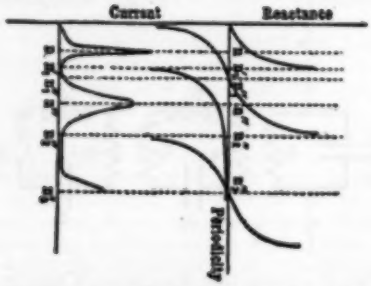


FIG. 4.—GRAPHICAL DEMONSTRATION OF SELECTIVITY.

of that periodicity the energy of the oscillations set up in the vertical oscillator is transmitted directly to the receiver, but persistent trains of waves of other frequencies either produce but slight response in the vertical oscillator or else produce oscillations of the periodicity n'', or of a periodicity slightly higher than n_3''. To such periodicity the "weeding-out circuit," and the circuit containing the receiver are extremely irresponsive, so that the receiving device receives but an inappreciable amount of the energy of the waves. In the case of impulsive waves the vertical wire tends to respond only to its own natural rates of vibration as affected by the loop circuit, that is to say, it tends to oscillate at periodicity n'' and to upper harmonics. Such waves acting on the vertical wire, have little tendency to develop oscillations of the natural period of the loop circuit as affected by its connection with the vertical wire, namely n, and the receiver is therefore also protected from the effects of such waves.

All that has been said regarding the effects of electrostatic and magnetic hysteresis in the description of transmitting station applies with added force to the apparatus at the receiving station. It is, in fact, much more important to exclude the effects of hysteresis from the receiving circuits than from the transmitting circuits, and it may be laid down as an important rule that under no circumstances shall solid or liquid dielectrics be used in the receiving circuits. Moreover, the injunction in regard to making the mutual inductance small between oscillators at the transmitting station applies in the case of the resonant circuits at the receiving

station, since if the mutual energies of the related resonant circuits be not small compared to their self energies, the resonant circuits will modify one another's natural periods, and each circuit will respond to more than one periodicity. Finally, it may be said that the measure of selectivity of a resonant circuit is proportional to $\sqrt{L/R^2S}$, this expression being the same as that found in connection with the persistency of an oscillating circuit. For a given periodicity, therefore, the selectivity is proportional to LN/R. So great is the selectivity of resonant circuits constructed of air condensers and properly designed inductance coils that there is no difficulty in adjusting such circuits to resonance for a given frequency with an error of less than 1 part in 3000. The importance of the "weeding-out circuit" at the receiving station becomes apparent when we observe that the selectivity of the receiving vertical oscillator is greatly diminished by the dissipation of energy, which results from the reradiation of energy by that oscillator, and that the selectivity of the resonant circuit containing the receiver may be greatly diminished by the energy absorbed by the receiver and utilized in its operation.

ATTACK BY THE TORPEDO-BOAT No. 35.[1]

The following are extracts from a letter of Lieutenant Soejima, who commanded the torpedo-boat No. 35 in the battle of the Sea of Japan:

May 27, 6.30 p. m. Approached the enemy with the object of attacking him, following the leading boat.

8.30 p. m. Saw Russian ships fire and ascertained their positions.

8.45 p. m. Lost sight of the leading boat on account of the high seas and darkness. We searched for it but could not find it. So fearing to miss the chance we decided to attack singly, and rushed underneath the enemy's searchlights increasing our speed.

9 p. m. Passed ahead of the enemy and steered as shown in the diagram. First we turned a little to port and after steaming for about 6 minutes we discovered (B) group which carried no lights. We approached them, as shown in the diagram, and examined them minutely. Two of them had 2 masts and 2 funnels, and the other two 2 masts and 3 funnels. As they resembled very much a certain division of ours, we did not attack them but decided to attack the last ship of (A) group, which was using her searchlight.

At that time the sea was very rough. The waves washed the deck and spray entered through the funnel. About 30 feet of the fore part of the boat was practically under water. I was standing behind the conning-tower, and the water fell upon me like a waterfall now and then. We could not steer as we pleased and I thought we could execute an attack.

9.30 p. m. Launched 2 torpedoes.

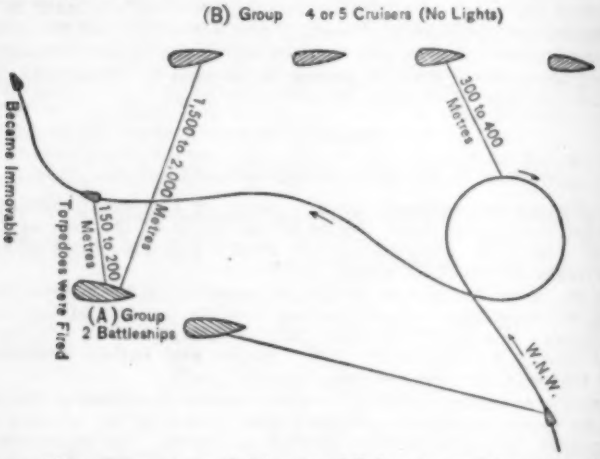
About 5 minutes before we launched the torpedoes we were discovered by the searchlight of the enemy. We tried to avoid it with a speed of over 20 knots, but we were pursued by the searchlight and received a furious concentrated fire. Fortunately we did not receive any damage then. We then approached the enemy's ship. When they turned their searchlight we saw men on the after deck, and thus we knew that we were very near to the ship (from 160 to 200 yards). We launched torpedoes. The results we did not ascertain on account of the enemy's searchlight and rough seas, but I believe that we gave a battleship of 2 masts and 2 funnels greater damage than my boat received.

Just at the time we were firing a torpedo from the tube aft, a small caliber shell exploded at the officer's room below the tube. One man was wounded and two were thrown down. But they jumped up and effected the firing. Not 2 minutes after this a 15-cm. shell struck the

[1] Translated from the *Tokyo Asahi*, July 3.

engine. The steam rushed out and the boat stood still. We could not move an inch. The escaping steam gave a good mark to the enemy, and the last ships of both (*A*) and (*B*) groups turned upon us their searchlights and poured a tremendous fire from guns of all description. Now shells fell upon us like showers, masts and funnels were broken, engine damaged, officer's room shattered, the hull pierced through like a honeycomb, and the water rushing in. (At that time the lieutenant was wounded but was giving his directions to his officers and men creeping.) It is indeed wonderful that in such a hard fighting the boat lost only 2 killed and 10 wounded.

The crew with great exertions managed to stop the leak temporarily, but by that time every part of the boat had been filled with water from 1 to 2 feet deep.



10 p. m. The enemy turned his searchlights to another direction and stopped firing upon us. I then examined the boat and removed the torpedoes from forward to amidship, as a precaution against accident. The boat received 22 shells and innumerable machine gun bullets.

11.30 p. m. We met a comrade boat and asked her to tow us. Ropes and anchor chain were tried but they parted three times on account of the rough seas. We therefore decided to wait till dawn. All this while we were engaged in stopping the leak.

When I was wounded I did not feel much pain and remained at my post. Now I had the wound dressed and took rest.

May 28, 3 a.m. Water rushed in from holes above the water-line, and as I saw it was now in vain to try to keep afloat, I asked a comrade boat for the last help. The wounded and important papers were removed to that boat and the men to another.

3.25 a. m. The ensign was hauled down and I with 3 officers left the torpedo-boat in a boat. No sooner had we left her, than she sank.

BOOK NOTICES.

"The China-Japan War," compiled from Japanese, Chinese and foreign sources. By Vladimir (lately of the Diplomatic Mission to Corea).

The intense interest evinced by the military as well as the general public in the results of the present great war in the East makes the reproduction of this volume more than timely as illustrating the military development of modern Japan, after three hundred years, practically of peace, under one dynasty. The author says of the China-Japan War: "It is an event which has already produced great results and it bids fair to produce even greater ones and to rank as one of the great events of the century. Indeed, for the magnitude, nature, and duration of its results we think it will rank as the great war of the century. Even in a few months, after the first battles, we find that it produced a most rapid and startling change of public opinion. Her victories were the more conspicuous because so unsuspected; none of the brave writers who had formed western opinions of the far East had ever given a thought to the military power of Japan; all serious consideration was given to China, and she was supposed to be carefully nursed to become the ally of Great Britain, as the only nation sufficiently powerful to arrest the eastern expansion of Russia. To appreciate justly the merit of Japan, and the rapidity of her assimilation of foreign civilization, it is necessary to bear in mind that the present war is the first foreign war that Japan has waged for the last three centuries, and that it was her first experiment with the new weapons and tactics which she has so lately adopted from the West." The author, in speaking of his sources of information, says: "My preference of Japanese sources does not affect the impartiality of the narration—the Japanese have been uniformally fair to their adversaries, far more just than their own countrymen; and it has always been easier to find the truth in the histories of the victors than in those of the vanquished. The former have greater self-possession, see events more clearly, and can afford to be impartial."

(Bound in cloth, $1.50. Franklin Hudson Publishing Co., Kansas City, Mo.)

"The Provisioning of the Modern Army in the Field." By Col. Henry G. Sharpe, Assistant Commissary General of the U. S. Army.

The author has made a profound study of the subject for years and the book embodies in condensed and brilliant form the result not only of wide research, but of actual experience, for Colonel Sharpe besides being a theorist and student has had experience in the varied fields of activity in his department in time of peace and in the field in time of war.

(Cloth, with maps and diagrams, $1.50. Franklin Hudson Publishing Co., Kansas City, Mo.)

"The Truth About the War." By Y. Taburno.

The author of this book, a civil engineer by profession and a special correspondent of the *Novoe Vremia*, went to the scene of military operations in December, 1904, for the purpose, as stated in the brief preface of his work, of "becoming acquainted with the true condition of our troops in Manchuria, and presenting it in its true light." In April, 1905, he placed before the public the results of his observations in a book entitled, "The Truth About the War," which, in addition to its literary merit, is an accurate, unprejudiced, impartial account of the operations near Mukden, and a sincere and conscientious research into the cause of Russian failure. The translation, published by the Franklin Hudson Publishing Co. of Kansas City, Mo., is by Victoria von Kreuter, and appears to be excellently done.

"David G. Farragut." By John R. Spears.

Mr. John R. Spears has ably presented a popular and technical volume in which the personal qualities and professional attainments of our great admiral are masterfully set forth.

The book is dedicated to "The Men of the American Navy Who Believe with Admiral Farragut that the Best Protection Against the Enemy's Fire is a Well-Directed Fire from Our Own Guns." With the substance of this dedicatory phrase in mind the author expresses the opinion that the best fighting ships of the future should have lighter armor, greater speed and more effective batteries than at present.

The author has condensed in this admirable biography an outline of our naval history and policy during the time of Farragut. He has given entertaining and accurate descriptions of the many battles in which the hero was engaged. From the life-like portrait of Farragut in frontispiece, to the copious index, the book is good, rich in anecdotes and facts, and replete with thrilling accounts of courageous deeds. A particularly interesting portion describes the hazardous passage of Port Hudson and the dangerous duty performed by Farragut in person, blockading the rivers above whereby supplies from the Red River country were cut off from Vicksburg and the capture of that besieged fortress made certain.

The author gives high praise to the Confederate naval officers, but criticizes the Confederate authorities for their policy toward their navy, saying: "In short, from Jefferson Davis, with his West Point training, down through the Confederate Congress, and the State authorities to the backwoods politicians, there was scarcely a man who was not infected with that old-time prejudice against the navy which had roiled John Randolph of Virginia and D. R. Williams of South Carolina. The army was to accomplish everything, and the one characteristic needed in that army was valor."

Mr. Spears has done more than to present accurately the life-story of Farragut. He has set forth in felicitous words the high courage and strong efforts of many naval officers whose attainments differed from Farragut's in quantity—not in quality.

The author's words ring true and he evidently has consulted more authorities than are mentioned in his bibliography of seventy-two items.

The casual reader will find much pleasing narrative and some unpleasant history in the book. The critical reader will find between its navy blue covers accounts of much of the naval strategy and tactics of the Civil War, Mexican War, and War of 1812.

CHARLES W. STEWART.

(George W. Jacobs & Co., Publishers, Philadelphia.)

"From the Yalu to Port Arthur, an Epitome of the Russo-Japanese War." By Lieutenant-Colonel O. E. Wood, late military attaché at Tokio, Japan, is, as its name indicates, *an epitome*. The author is an officer of long and gallant service, and the book is well worthy of him.

In reading the volume one is particularly struck with the logical arrangement of the subject-matter in the successive chapters, and from the beginning one is impressed with a feeling of confidence in the accuracy of the narrative. It is a most valuable book for the student, because it is logical in its arrangement and accurate in its statements. While the author's deductions, it is thought, do not always carry the weight of conviction, they are at least entitled to hearty respect. The story of the Yalu is much condensed, and the author sounds the keynote of Japanese success in the one word, "preparedness." In connection with the Japanese success at the Yalu, the author briefly mentioned what was at that time a profound military secret, namely, the fact that at the time Kuroki fought the battle of the Yalu, the Second Army, under General Oku, awaited results on their transports behind the Elliott Islands east of the Liaotung Peninsula. Had Kuroki been unable to advance, the move of Oku would have been against the Russian right flank, but the result being a success for the Japanese, Oku landed on the coast of the Liaotung Peninsula, and, after several unimportant engagements, fought and won the decisive battle of Nanshan Hill. The battle of Tehlitz, fought on June 15, is described by the author as the most important of the war up to that time, for the reason that the Russians were defeated in a battle which represented the strongest effort of Kuropatkin to restore the situation. The author gives the numbers in this battle as 30,000 men and 96 guns on the part of the Russians, commanded by General Stackleberg, against 24,000 men and 98 guns on the part of the Japanese, commanded by General Oku. In a very brief description of this battle, the author states that the Japanese forces were twice reinforced by the general infantry reserve of the army, but their position was becoming almost insupportable when a body of Japanese cavalry arrived on the scene and threatened the left of the Russians, who made vigorous resistance, but were finally compelled to retreat.

The situation of the Japanese on August 1, after ten successful battles, is commented upon with convincing exactness. The point dwelt upon throughout being the co-ordination of the various elements, the armies of Kuroki, Oku, and Nodzu, which he describes as being, at this time, united in a resistless whole under Field Marshal Oyama.

The description of the battle of Liaoyang is quoted from Field Marshal

Oyama's official report and naturally lacks information, only obtainable from Russian sources. The author's deductions from the results of the ten days' battle of Liaoyang are clear, concise, and convincing; the inference drawn is that the Japanese were fought to a standstill by the Russians behind semi-permanent works; that the Russians, while defeated, were, owing to the wisdom and soldierly acumen of Kuropatkin, able to withdraw at the proper time without a crippling loss. As the author expresses it: "Kuropatkin has shown himself clever in retreat, he manages to draw off his men without crippling loss, but continual retreats do not win campaigns."

Part two of the book deals with the investment and siege of Port Arthur, the details of which, the author states, were kept a profound secret for over four months following the battle of Nanshan Hill, and they were only given out in a concise official statement, which he quotes entire. This report covers some sixty pages of the book, and is an invaluable official epitome of the greatest siege of modern times. The author places the Japanese losses in this siege in killed and wounded as between forty and fifty thousand, but says it is only an estimate, since the Japanese authorities have never published them.

The last twenty-five pages of the book are taken up mainly with unofficial reports of the details of the siege, and an account of the author's visit to Port Arthur, he being among the first of the foreign officers to visit that city after the surrender. In describing the appearance of the Russian forts and trenches from the Japanese positions, the author makes special mention of their visibility in contradistinction to the absolute invisibility of the Japanese approaches when viewed from the Russian position. The description of the havoc wrought among the Russian naval vessels in the harbor of Port Arthur by the Japanese guns from the position near 203 Meter Hill, from which they were destroyed by a system of high-angle fire, new in the history of warfare, is most interesting and instructive.

The book cannot but prove of professional value to officers of the naval and military professions.

(Franklin Hudson Publishing Co., Kansas City, Mo.)

"Mechanical Processes." A practical treatise on workshop appliances and operations for the instruction of midshipmen at the U. S. Naval Academy. By John K. Barton, Commander, U. S. Navy, Head of Department of Marine Engineering and Naval Construction.

In this work the author loses no time dealing with the historical side of the subject or antiquated methods, but proceeds directly to describe the materials in use at the present day, metals, ores, fuels, solid and gaseous, refractory substances, etc., then shows how these are employed and why, illustrating fully with clear sketches, going into the matter in sufficient detail to be interesting without being tedious.

The subject of steel-making is then taken up and all of the processes in modern use described, including the valuable but comparatively little-known Tropenas process. The properties and uses of some special steels, copper, tin, bronzes, etc., are also treated in this chapter.

Chapter III treats of pattern-making, the machines and tools used, giving a list of the names of the latter illustrated by a cut of each, a great help to the student in learning to call things by their right name.

The processes are described, beginning with simple objects and leading up to the complicated one of making a pattern for a screw propeller, which is treated in a very full and satisfactory manner.

Chapter IV deals with iron moulding and casting, cylinders and propellers getting the large share of attention which the intricacy of these subjects demand.

The remaining chapters cover, in the same manner, steel castings; the forge, machine-shop equipment, vise work and tools; machine tools, lathe tools and attachments, other forms of lathes and machine tools; boring mills and milling machines; boiler shop, the manufacture of seamless drawn steel tubes, pneumatic riveting machines, etc.

In each case the matter is much condensed and at the same time made clearer by the free use of sketches and cuts.

An appendix contains some data on high-speed steels and an interesting account of the properties and uses of thermit, a new and valuable aid in repair work, especially on shipboard. There are also extracts from the Bureau of Steam Engineering Specifications pertinent to the subject-matter of the book; tables of alloys; sizes of tap drills; sheet and plate gauges; weight of iron and steel sheets; square and round bars; unit weights per square foot; weights of castings from patterns; standard wire gauges and U. S. screw threads, hydraulic data; and the dimensions of iron pipe.

The book contains much detailed and specific information which is not readily accessible to the student, some of it being found scattered in technical journals and the balance obtained from engineers and mechanics actually engaged in doing the work. Only those who have tried, realize how difficult it is to get this kind of information, as good workmen are often poor hands at describing their methods. Much of the information was formerly, at the Naval Academy, supposed to be imparted to the midshipmen orally by the mechanics detailed to instruct them in the shops, but as a matter of fact the amount of oral instruction they got in this was extremely meager. With the aid of this text-book each student is certain to receive all of the necessary information and to understand a great deal better what he is about when at work.

This volume will also prove most useful to every line officer in the navy, all of whom, from time to time, inevitably have engineering work to do, either with the main engines, torpedoes, dynamos, or guns, or on boards of surveys, to pass judgment on breakages or casualties, condemn worn-out mechanism, to judge the suitability of methods proposed for repairs and alterations and the estimates for the same. To do such duty reasonably well it is essential that an officer be familiar with the mechanical processes, machines, and tools described.

W. F. W.

LIST OF PRIZE ESSAYS.

1879.

Naval Education. Prize Essay, 1879. By Lieut.-Com. A. D. Brown, U.S.N.

NAVAL EDUCATION. First Honorable Mention. By Lieut.-Com. C. F. Goodrich, U.S.N.

NAVAL EDUCATION. Second Honorable Mention. By Commander A. T. Mahan, U.S.N.

1880.

"The Naval Policy of the United States." Prize Essay, 1880. By Lieutenant Charles Belknap, U.S.N.

1881.

The Type of (I) Armored Vessel, (II) Cruiser best suited to the Present Needs of the United States. Prize Essay, 1881. By Lieutenant E. W. Very, U.S.N.

SECOND PRIZE ESSAY, 1881. By Lieutenant Seaton Schroeder, U.S.N.

1882.

Our Merchant Marine: The Causes of its Decline and the Means to be taken for its Revival. "Nil clarius aquis." Prize Essay, 1882. By Lieutenant J. D. J. Kelley, U.S.N.

"MAIS IL FAUT CULTIVER NOTRE JARDIN." Honorable Mention. By Master C. G. Calkins, U.S.N.

"SPERO MELIORA." Honorable Mention. By Lieut.-Com. F. F. Chadwick, U.S.N.

"CAUSA LATET: VIS EST NOTISSIMA." Honorable Mention. By Lieutenant R. Wainwright, U.S.N.

1883.

How may the Sphere of Usefulness of Naval Officers be extended in Time of Peace with Advantage to the Country and the Naval Service? "Pour encourager les Autres." Prize Essay, 1883. By Lieutenant Carlos G. Calkins, U.S.N.

"SEMPER PARATUS." First Honorable Mention. By Commander N. H. Farquhar, U.S.N.

"CUILIBET IN ARTE SUA CREDENDUM EST." Second Honorable Mention. By Captain A. P. Cooke, U.S.N.

1884.

The Reconstruction and Increase of the Navy. Prize Essay, 1884. By Ensign W. I. Chambers, U.S.N.

1885.

Inducements for Retaining Trained Seamen in the Navy, and Best System of Rewards for Long and Faithful Service. Prize Essay, 1885. By Commander N. H. Farquhar, U.S.N.

1886.

What Changes in Organization and Drill are Necessary to Sail and Fight Effectively Our Warships of Latest Type? "Scire quod nescias." Prize Essay, 1886. By Lieutenant Carlos G. Calkins, U.S.N.

THE RESULT OF ALL NAVAL ADMINISTRATION AND EFFORT FINDS ITS EXPRESSION IN GOOD ORGANIZATION AND THOROUGH DRILL ON BOARD OF SUITABLE SHIPS. Honorable Mention. By Ensign W. L. Rodgers, U.S.N.

1887.

The Naval Brigade: its Organization, Equipment and Tactics. "In hoc signo vinces." Prize Essay, 1887. By Lieutenant C. T. Hutchins, U.S.N.

1888.

Torpedoes. Prize Essay, 1888. By Lieut.-Com. W. W. Reisinger, U.S.N.

1891.

The Enlistment, Training and Organization of Crews for our Ships of War. Prize Essay, 1891. By Ensign A. P. Niblack, U.S.N.

DISPOSITION AND EMPLOYMENT OF THE FLEET: SHIP AND SQUADRON DRILL. Honorable Mention, 1891. By Lieutenant R. C. Smith, U.S.N.

1892.

Torpedo-boats: their Organization and Conduct. Prize Essay, 1892. By Wm. Laird Clowes.

1894.

The U.S.S. Vesuvius, with Special Reference to her Pneumatic Battery. Prize Essay, 1894. By Lieut.-Com. Seaton Schroeder, U.S.N.

NAVAL REFORM. Honorable Mention, 1894. By Passed Assistant Engineer F. M. Bennett, U.S.N.

1895.

Tactical Problems in Naval Warfare. Prize Essay, 1895. By Lieut.-Com. Richard Wainwright, U.S.N.

A SUMMARY OF THE SITUATION AND OUTLOOK IN EUROPE. An Introduction to the Study of Coming War. Honorable Mention, 1895. By Richmond Pearson Hobson, Assistant Naval Constructor, U.S.N.

SUGGESTIONS FOR INCREASING THE EFFICIENCY OF OUR NEW SHIPS. Honorable Mention, 1895. By Naval Constructor Wm. J. Baxter, U.S.N.

THE BATTLE OF THE YALU. Honorable Mention, 1895. By Ensign Frank Marble, U.S.N.

1896.

The Tactics of Ships in the Line of Battle. Prize Essay, 1896. By Lieutenant A. P. Niblack, U.S.N.

THE ORGANIZATION, TRAINING AND DISCIPLINE OF THE NAVY PERSONNEL AS VIEWED FROM THE SHIP. Honorable Mention, 1896. By Lieutenant Wm. F. Fullam, U.S.N.

NAVAL APPRENTICES, INDUCEMENTS, ENLISTING AND TRAINING. The Seaman Branch of the Navy. Honorable Mention, 1896. By Ensign Ryland D. Tisdale, U.S.N.

THE COMPOSITION OF THE FLEET. Honorable Mention, 1896. By Lieutenant John M. Ellicott, U.S.N.

1897.

Torpedo-boat Policy. Prize Essay, 1897. By Lieutenant R. C. Smith, U.S.N.

A PROPOSED UNIFORM COURSE OF INSTRUCTION FOR THE NAVAL MILITIA. Honorable Mention, 1897. By H. G. Dohrman, Associate Member, U.S.N.I.

TORPEDOES IN EXERCISE AND BATTLE. Honorable Mention, 1897. By Lieutenant J. M. Ellicott, U.S.N.

1898.

Esprit de Corps: A Tract for the Times. Prize Essay, 1898. By Captain Caspar Frederick Goodrich, U.S.N.

OUR NAVAL POWER. Honorable Mention, 1898. By Lieut.-Com. Richard Wainwright, U.S.N.

TARGET PRACTICE AND THE TRAINING OF GUN CAPTAINS. Honorable Mention, 1898. By Ensign R. H. Jackson, U.S.N.

1900.

Torpedo Craft: Types and Employment. Prize Essay, 1900. By Lieutenant R. H. Jackson, U.S.N.

THE AUTOMOBILE TORPEDO AND ITS USES. Honorable Mention, 1900. By Lieutenant L. H. Chandler, U.S.N.

1901.

Naval Administration and Organization. Prize Essay, 1901. By Lieutenant John Hood, U.S.N.

1903.

Gunnery in Our Navy. The Causes of its Inferiority and Their Remedies. Prize Essay, 1903. By Professor Philip R. Alger, U.S.N.

A NAVAL TRAINING POLICY AND SYSTEM. Honorable Mention, 1903. By Lieutenant James H. Reid, U.S.N.

SYSTEMATIC TRAINING OF THE ENLISTED PERSONNEL OF THE NAVY. Honorable Mention, 1903. By Lieutenant C. L. Hussey, U.S.N.

OUR TORPEDO-BOAT FLOTILLA. The Training Needed to Insure its Efficiency. Honorable Mention, 1903. By Lieutenant E. L. Beach, U.S.N.

1904.

The Fleet and its Personnel. Prize Essay, 1904. By Lieutenant S. P. Fullinwider, U. S. N.

A PLEA FOR A HIGHER PHYSICAL, MORAL, AND INTELLECTUAL STANDARD OF THE PERSONNEL FOR THE NAVY. Honorable Mention, 1904. By Medical Inspector Howard E. Ames, U. S. N.

1905.

American Naval Policy. Prize Essay, 1905. By Commander Bradley A. Fiske, U. S. N.

THE DEPARTMENT OF THE NAVY. Honorable Mention, 1905. By Rear-Admiral Stephen B. Luce, U. S. N.

NOTICE.

The U. S. Naval Institute was established in 1873, having for its object the advancement of professional and scientific knowledge in the Navy. It now enters upon its thirty-second year of existence, trusting as heretofore for its support to the officers and friends of the Navy. The members of the Board of Control cordially invite the co-operation and aid of their brother officers and others interested in the Navy, in furtherance of the aims of the Institute, by the contribution of papers and communications upon subjects of interest to the naval profession, as well as by personal support and influence.

On the subject of membership the Constitution reads as follows:

ARTICLE VII.

Sec. 1. The Institute shall consist of regular, life, honorary and associate members.

Sec. 2. Officers of the Navy, Marine Corps, and all civil officers attached to the Naval Service, shall be entitled to become regular or life members, without ballot, on payment of dues or fee to the Secretary and Treasurer, or to the Corresponding Secretary of a Branch. Members who resign from the Navy subsequent to joining the Institute will be regarded as belonging to the class described in this Section.

Sec. 3. The Prize Essayist of each year shall be a life member without payment of fee.

Sec. 4. Honorary members shall be selected from distinguished Naval and Military Officers, and from eminent men of learning in civil life. The Secretary of the Navy shall be, *ex officio*, an honorary member. Their number shall not exceed thirty (30). Nominations for honorary members must be favorably reported by the Board of Control, and a vote equal to one-half the number of regular and life members, given by proxy or presence, shall be cast, a majority electing.

Sec. 5. Associate members shall be elected from Officers of the Army Revenue Marine, foreign officers of the Naval and Military professions, and from persons in civil life who may be interested in the purposes of the Institute.

Sec. 6. Those entitled to become associate members may be elected life members, provided that the number not officially connected with the Navy and Marine Corps shall not at any time exceed one hundred (100).

Sec. 7. Associate members and life members, other than those entitled to regular membership, shall be elected as follows: "Nominations shall be made in writing to the Secretary and Treasurer, with the name of the member making them, and such nominations shall be submitted to the Board of Control, and, if their report be favorable, the Secretary and Treasurer shall make known the result at the next meeting of the Institute, and a vote shall then be taken, a majority of votes cast by members present electing.

The Proceedings are published quarterly, and may be obtained by non-members upon application to the Secretary and Treasurer at Annapolis, Md. Inventors of articles connected with the naval profession will be afforded an opportunity of exhibiting and explaining their inventions. A description of such inventions as may be deemed by the Board of Control of use to the service will be published in the Proceedings.

Single copies of the Proceedings, $1.00. Back numbers and complete sets can be obtained by applying to the Secretary and Treasurer, Annapolis, Md.

Annual subscriptions for non-members, $3.50. Annual dues for members and associate members, $3.00. Life members fee, $30.00.

All letters should be addressed to Secretary and Treasurer, U. S. Naval Institute, Annapolis, Md., and all checks, drafts and money orders should be made payable to his order, without using the name of that officer.

The amended Constitution, which follows, was adopted by 437 affirmative votes out of a total vote of 442.

CONSTITUTION AND BY-LAWS.

ARTICLE I.—TITLE.

This organization shall be called the United States Naval Institute.

ARTICLE II.—OBJECT.

Its object is the advancement of professional, literary, and scientific knowledge in the navy.

ARTICLE III.—HEADQUARTERS.

The headquarters of the Institute shall be at the United States Naval Academy, Annapolis, Md.

ARTICLE IV.—OFFICERS.

The officers shall be as follows:

A President.

A Vice-President.

A Board of Control.

A Secretary and Treasurer.

ARTICLE V.—ELECTION OF OFFICERS.

SECTION 1. There shall be a meeting of the Institute at headquarters on the second Friday in October of each year, of which at least two weeks' notice shall be given, at which meeting all the foregoing officers shall be elected by ballot in open session, and a majority of votes given by presence or proxy shall elect; regular or life members only being eligible for office.

SEC. 2. Absent members who have the constitutional right to vote may vote by proxy at such elections, and in the same manner on all questions involving changes in the Constitution and By-Laws, and upon questions involving the expulsion of members and the election of honorary members. On all other questions voting must be by actual presence. Life members shall have the full right of regular members to vote on every question. Honorary and associate members shall not have the privilege of voting. Each proxy must be signed by the member whose vote is to be represented.

SEC. 3. Members elected to the position of officers of the Institute will assume their respective duties at the date from which elected.

SEC. 4. Casual vacancies in the offices of the Institute may be temporarily filled by the Board of Control.

ARTICLE VI.—DUTIES OF OFFICERS.

SECTION 1. The President shall preside at business meetings of the Institute at which he may be present.

SEC. 2. In the absence of the President, the Vice-President shall preside.

SEC. 3. The Board of Control shall consist of seven members in good standing, regular or life, and its duties shall be the management of all the financial and administrative business of the Institute, including the censorship, printing, and control of its publications. The Secretary and Treasurer shall be, *ex-officio*, a member of the Board, its medium of communication, and the recorder of its transactions. Regular meetings of the Board of Control shall be held when called by the Secretary and Treasurer, and he shall issue a call for a special meeting at any time upon the written request of two members of the Board. A quorum shall consist of three members. In the absence of both the President and Vice-President at business meetings of the Institute, a member of the Board of Control shall preside. It shall be the duty of this Board to appoint a committee of three of its own members to audit and certify the books and accounts of the Secretary and Treasurer once every year.

SEC. 4. The Secretary and Treasurer shall keep a register of the members in which shall be noted all changes; an authenticated copy of the Constitution and By-Laws in force; a journal of the Proceedings of the Institute; a separate journal of the transactions of the Board of Control; a receipt and expenditure book; an account-current with each member. Under the authority of the Board of Control, he shall be the disbursing and purchasing officer of the Institute and the custodian of the funds, securities, and assets, and it shall be his duty to furnish members with receipts for dues paid. He shall attend to all correspondence and keep a record thereof, give due notice of meetings of the Institute and Board of Control, have charge of the stenographer and copyists employed to prepare records of the Proceedings, and he shall

distribute all publications. The books of accounts of the Institute shall always be open to inspection by any member.

ARTICLE VII.—MEMBERSHIP.

SECTION 1. The Institute shall consist of regular, life, honorary, and associate members.

SEC. 2. Officers of the navy, marine corps, and all civil officers attached to the naval service, shall be entitled to become regular or life members, without ballot, on payment of dues or fees to the Secretary and Treasurer. Members who resign from the navy subsequent to joining the Institute will be regarded as belonging to the class described in this section.

SEC. 3. The Prize Essayist of each year shall be a life member without payment of fee.

SEC. 4. Honorary members shall be selected from distinguished naval and military officers, and from eminent men of learning in civil life. The Secretary of the Navy shall be, *ex-officio*, an honorary member. Their number shall not exceed thirty (30). Nominations for honorary members must be favorably reported by the Board of Control, and a vote equal to one-half the number of regular and life members, given by proxy or presence, shall be cast, a majority electing.

SEC. 5. Associate members shall be elected from officers of the army, revenue marine, foreign officers of the naval and military professions, and from persons in civil life who may be interested in the purposes of the Institute.

SEC. 6. Those entitled to become associate members may be elected life members, provided that the number not officially connected with the navy and marine corps shall not at any time exceed one hundred (100).

SEC. 7. Associate members and life members, other than those entitled to regular membership, shall be elected as follows: Nominations shall be made in writing to the Secretary and Treasurer, with the name of the member making them, and such nominations shall be submitted to the Board of Control, and, if their report be favorable, the Secretary and Treasurer shall make known the result at the next meeting of the Institute, and a vote shall then be taken, a majority of votes cast by members present electing.

SEC. 8. The annual dues for regular and associate members

shall be three dollars, payable upon joining the Institute, and upon the first day of each succeeding January. The fee for life membership shall be thirty dollars, but if any regular or associate member has paid his dues for the year in which he wishes to be transferred to life membership, or has paid his dues for any future year or years, the amount so paid shall be deducted from the fee for life membership.

SEC. 9. No member of the Institute shall be dismissed except by recommendation of the Board of Control, and by a two-thirds vote of the members of the Institute voting at any regular or called meeting, of which at least one month's notice shall be given. Without the recommendation of the Board of Control, no member can be dismissed except by a three-fourths vote. In both the above cases there must be a total vote of at least a majority of all those members entitled to a vote, the voting to be either by presence or proxy. Members in arrears more than three years may, at the discretion of the Board of Control, be dropped for non-payment of dues.

ARTICLE VIII.—RESERVE FUND.

There shall be a Reserve Fund, consisting of the $3050 originally credited to that fund, together with all life-membership fees which have been or may hereafter be received, and the principal of this fund shall be held in perpetuity to guarantee the future interest of life members. The Reserve Fund shall be invested under the direction of the Board of Control, but no part of that fund shall be invested in any other than United States bonds unless by the unanimous vote of the Board of Control given in writing at a special meeting called for the purpose.

ARTICLE IX.—MEETINGS.

SECTION 1. Meetings of the Institute shall be called by the Secretary and Treasurer when directed by the Board of Control.

SEC. 2. Notice of meetings shall state the business that will be brought before the meeting.

SEC. 3. A stenographer may be employed when authorized by the Board of Control.

ARTICLE X.—PAPERS AND PROCEEDINGS.

SECTION 1. There shall be published quarterly, or as much oftener as the Board of Control may decide, "PROCEEDINGS OF

THE U. S. NAVAL INSTITUTE," containing such papers and discussions as are approved by the Board of Control, together with editorial and professional notes deemed of value to the service.

SEC. 2. One copy of the PROCEEDINGS, when published, shall be furnished to each regular, life, honorary, and associate member, to each corresponding society of the Institute, and to such libraries and periodicals as may be determined upon by the Board of Control.

SEC. 3. Copies of the PROCEEDINGS and complete sets may be sold at a charge fixed by the Board of Control, and the Board shall also fix the price of annual subscription for others than members.

SEC. 4. A receipt and expenditure account of the Institute's publications, showing the number on hand, shall be included in the report of the Secretary and Treasurer of each year.

SEC. 5. The Board of Control shall decide the size of the edition of each number of the PROCEEDINGS to be published, and also the number of reprints.

SEC. 6. The PROCEEDINGS shall be copyrighted in behalf of the Institute by the Secretary and Treasurer.

ARTICLE XI.—ANNUAL PRIZE ESSAY.

SECTION 1. A prize of two hundred dollars, with a gold medal, shall be offered each year for the best essay on any subject pertaining to the naval profession.

SEC. 2. The award for the above-named prize shall be made by the Board of Control, voting by ballot and without knowledge of the names of the competitors; and the time and manner of submitting such essays shall be determined and announced by said board.

SEC. 3. In the event of the prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of a gold medal.

ARTICLE XII.—AMENDMENTS.

No addition or amendment to the Constitution shall be made without the assent of two-thirds of the members voting; the By-Laws, however, may be amended by a majority vote. Notice of proposed changes or additions shall be given by the Secretary and Treasurer at least one month before action is taken upon them. A total vote equal to at least half the number of regular and life members shall be required.

BY-LAWS.

ARTICLE I.

The rules of the United States House of Representatives shall, in so far as applicable, govern the parliamentary proceedings of the Society.

ARTICLE II.

1. At both regular and stated meetings the routine of business shall be as follows:

2. At executive meetings, the President, or, in his absence, the Vice-President, or, in the absence of both, a member of the Board of Control, shall call the meeting to order, and occupy the chair during the session; in the absence of these, the meeting shall appoint a Chairman.

3. At meetings for the presentation of papers and discussion, the Society shall be called to order as above provided, and a Chairman shall be appointed by the presiding officer, reference being had to the subject about to be discussed, and an expert in the specialty to which it relates being selected.

4. At regular meetings after the presentation of the paper of the evening, or on the termination of the arguments made by members appointed to or voluntarily appearing to enter into formal discussion, the Chairman shall make such review of the paper as he may deem proper. Informal discussion shall then be in order, each speaker being allowed not exceeding ten minutes in the aggregate, unless by special consent of the society. The author of the paper shall, in conclusion, be allowed such time in making a résumé of the discussion as he may deem necessary. The discussion ended, the Chairman shall close the proceedings with such remarks as he may be pleased to offer.

5. At the close of the concluding remarks of the Chairman, the society shall go into executive session, as hereinbefore provided, for the transaction of business as follows:

1. Stated business, if there shall be any to be considered.
2. Unfinished business taken up.
3. Reports of officers and committees.
4. Applications for membership reported and voted upon.
5. Correspondence read.
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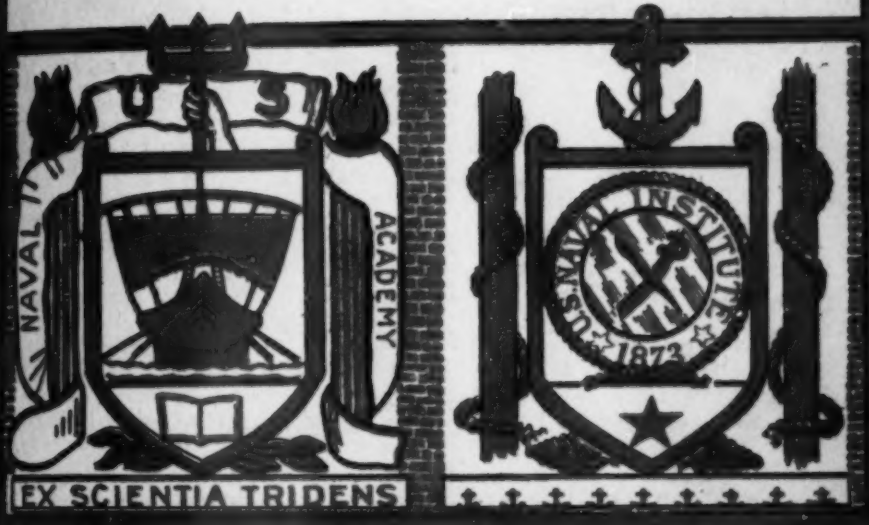

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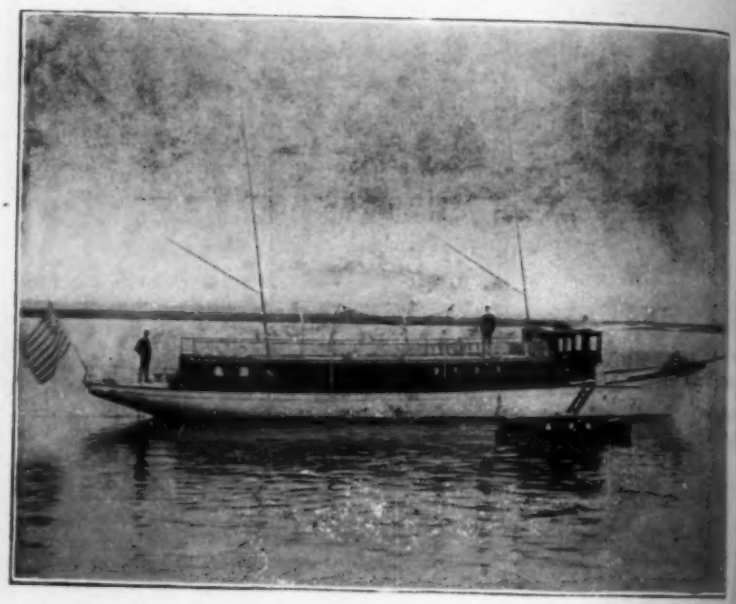

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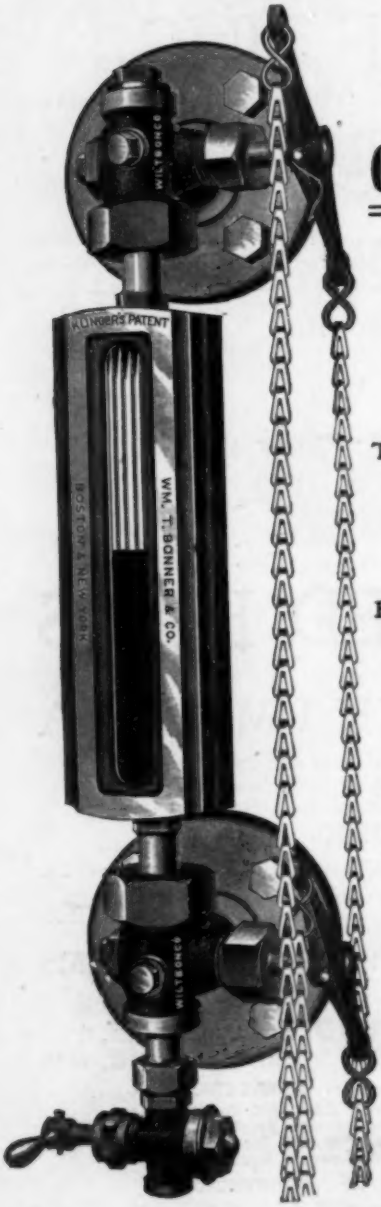

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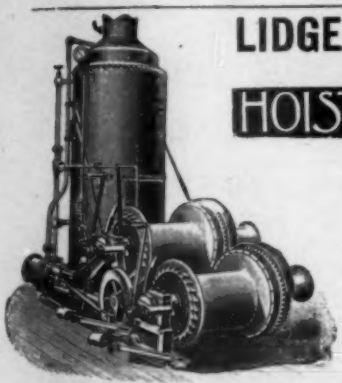

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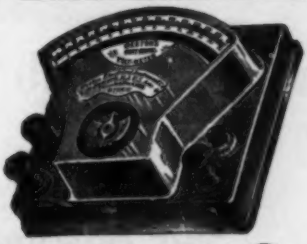

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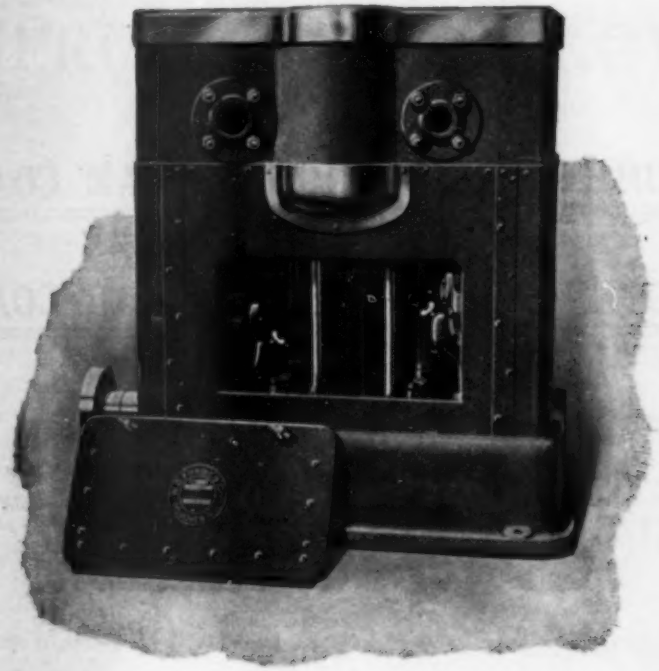

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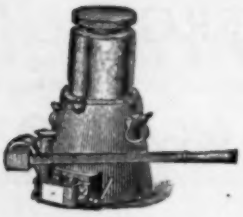
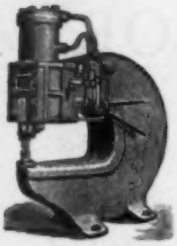


Horizontal
Outside Pump
Hydraulic Jack.
Sheet 20.



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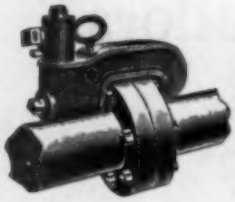

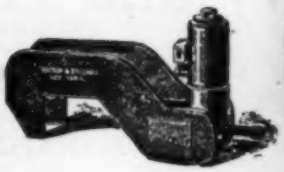

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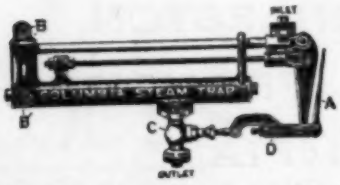

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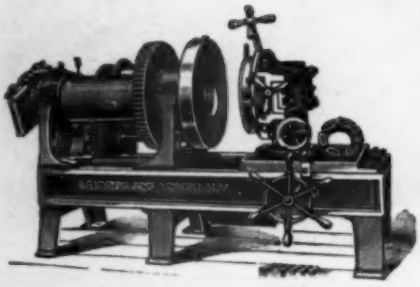

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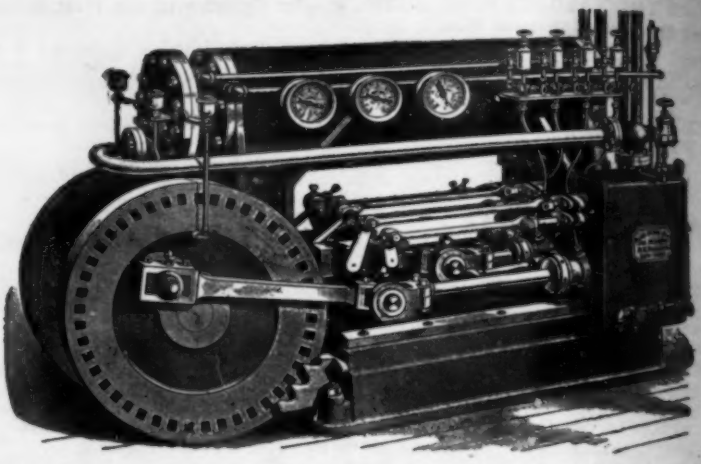

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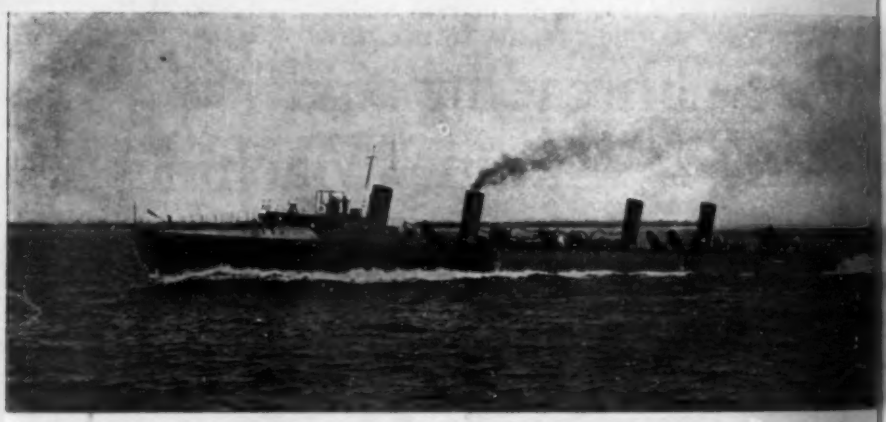

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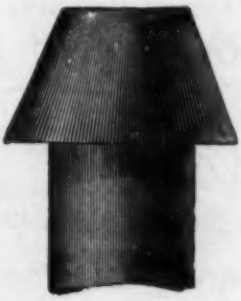

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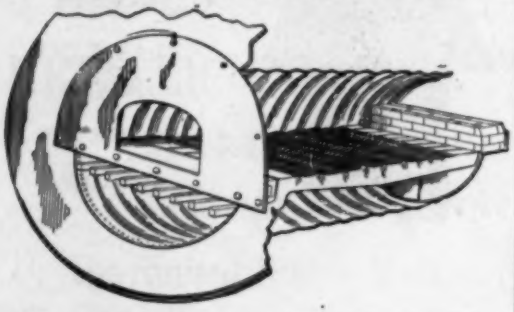

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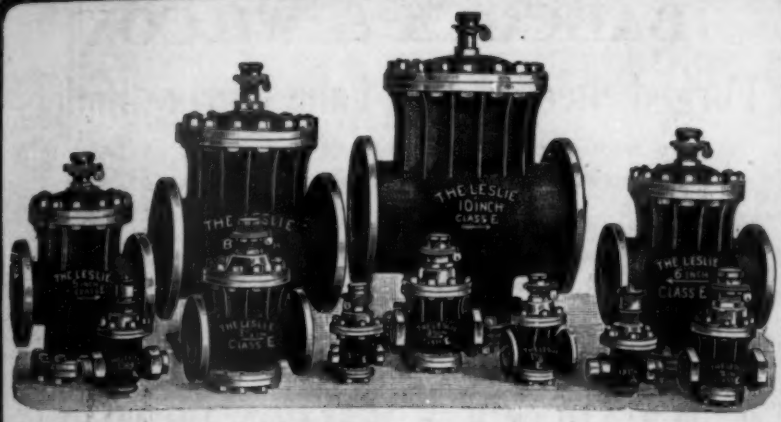

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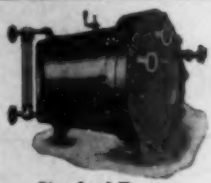

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